A star (*) indicates that the Abstract deals with Apparatus and Instruments.

NOVEMBER, 1940.

GENERAL PHYSICS.

ATOMIC AND MOLECULAR STRUCTURE.

2871. Problems and research methods of nuclear physics. H. Wäffler. *Assoc. Suisse Élect., Bull.*, **31**, *pp.* 25–29, *Jan.* 26, *and pp.* 282–288, *June* 28, 1940. *In German.*—The structure of the atom and nuclear forces are discussed, and a brief account of the atomic transformations effected by the impact of highly accelerated protons and neutrons given, with examples and calculation of the p.d. necessary to impart a velocity great enough to cause rupture of an atom, e.g. 15×10^6 V to split the atom of U; some account of the production of artificial radioactivity is also given. Production of rapid ions by means of the driving-belt and cascade generators and the cyclotron are described in detail. C. A. S.

2872. Continuum theory of the compound nucleus. H. A. Bethe. *Phys. Rev.*, **57**, *pp.* 1125–1144, *June* 15, 1940.—The theory of Bohr has shown that it is impossible to describe the collision of a particle with a nucleus as a one-body problem in which the nucleus is replaced by a potential field. A theory representing the particle as moving in a field with absorption, in which it has at any time a chance of disappearing, i.e. of giving up some of its energy to the rest of the nucleus, is more successful. The absorption coefficient introduced in this way is purely phenomenological; it is found that the results are very sensitive to the variation of this absorption coefficient near the surface of the nucleus and that reasonable results are obtained on the assumption that the decrease near the edge is gradually spread over a distance equal to the range of the intra-nuclear forces. The detailed results of this theory are discussed in relation to experimental data. R. P.

2873. Nuclear isotope shift in the spectra of HgH^+ and HgD^+. S. Mrozowski. *Phys. Rev.*, **58**, *pp.* 332–340, *Aug.* 15, 1940.—The structure of the lines in the band spectra of HgH^+ and HgD^+, excited in a hollow cathode tube, is studied with Fabry-Perot etalons. The lines are found to be broadened, with traces of structure, an effect caused by the isotopic constitution of mercury. The structure shows that there is no anomalous behaviour of components belonging to the odd Hg isotopes due to hyperfine splitting, but the half-widths of the lines differ widely from the expected ones. From the measured half-widths the shifts between the consecutive even isotopes of Hg are evaluated and then the differences between these and the values obtained from the formulae for the normal vibrational and rotational isotope effect calculated. These additional shifts show the same behaviour as the shifts found some years ago in HgH and HgD and therefore must be explained as nuclear isotope shifts, i.e. shifts connected with differences in nuclear volume of the different isotopes of Hg. For the lowest vibrational bands the shifts are of the same sign as in HgH but decrease with the vibrational energy of both upper and lower states, changing sign for sufficiently high vibrational energies and probably tending in the limit of dissociation to the shifts found in the corresponding quadrupole line 2 815 Å of Hg II. Consideration of the data on the nuclear isotope shifts in HgH, HgH^+, Hg I and Hg II permits some conclusions about the deformation of the electron clouds in Hg and Hg^+ caused by the attachment of a H-atom, and a rough calculation of the nuclear shifts in the molecular levels of HgH and HgH^+. AUTHOR.

2874. Isotopic weight of ^{12}C. K. OGATA. *Phys. Math. Soc., Japan, Proc.*, **22,** *pp.* 486–491, *June*, 1940.—The isotopic weight of ^{12}C as determined by Aston, Bainbridge and Jordan and by Matteuch, deduced from the doublets $^{14}NH_2 - {}^{16}O$, $^{14}N_2 - {}^{12}C^{16}O$ and $^{12}CH_2 - {}^{14}N + {}^{14}NH_2 - {}^{16}O$, have been recalculated, giving an average of $12 \cdot 003871 \pm 0 \cdot 33 \times 10^{-4}$. The doublet $^{12}C_3H_4 - {}^{40}A$ gives $12 \cdot 00387 \pm 0 \cdot 3 \times 10^{-4}$ (Aston: $12 \cdot 0036 \pm 2 \times 10^{-4}$); $^{12}CD_2 - {}^{16}O$ $12 \cdot 00371 \pm 0 \cdot 7 \times 10^{-4}$; and $^{10}BH_2 - {}^{12}C$ $12 \cdot 003666 \pm 2 \cdot 0 \times 10^{-4}$ (Bainbridge and Jordan and Aston). $^{12}C_2 - {}^{48}Ti^{++}$ and $^{16}O - {}^{48}Ti^{+++}$ as measured by Aston and Dempster, respectively, give $12 \cdot 0038 \pm 3 \times 10^{-4}$. The mean of all these results is $12 \cdot 00384 - 0 \cdot 35 \times 10^{-4}$. It is considered that Matteuch's result as recalculated, $12 \cdot 003847 \pm 0 \cdot 22 \times 10^{-4}$, is most probable. C. A. S.

2875. Directed valence in chemical reactions. J. L. MAGEE. *J. Chem. Phys.*, **8,** *pp.* 677–687, *Sept.*, 1940.—The potential-energy surfaces for the reactions of two hydrogen atoms with another hydrogen-like atom having a single valence electron in a $2p$ orbital are investigated. The simple Heitler-London approximation is used in the calculations.

2876. Solid states of H_2 and D_2. M. TODA. *Phys. Math. Soc. Japan, Proc.*, **22,** *pp.* 503–507, *June*, 1940.—Assuming that the interaction energy $\phi(r)$ $(= A/r^n - B/r^6 \times n > 6)$ between two mols. H_2 or D_2 is approximately represented as a function of r, the distance between their centres of mass, neglecting the dependence of $\phi(r)$ on the orientation of the molecular axes for H_2, $n = 9$, the lattice spacing of H_2 is calculated as $3 \cdot 81$, (lattice energy per mol./Loschmidt number) $\times 10^{-14}$ as $1 \cdot 11$ erg and the compressibility $\times 10^4 = 1 \cdot 4$ cm^2./kg.; with $n = 12$ the corresponding figures are $3 \cdot 72$, $1 \cdot 15$ and $4 \cdot 2$, as compared with the observed values $3 \cdot 77$, $1 \cdot 26$, and $5 \cdot 0 \pm 0 \cdot 5$; for D_2 they are $(n = 9)$ $3 \cdot 75$, $1 \cdot 50$, and $1 \cdot 0$, and $(n = 12)$ $3 \cdot 61$, $1 \cdot 60$ and $7 \cdot 0$, as compared with observed $3 \cdot 58$, $1 \cdot 89$ and $3 \cdot 3 \pm 0 \cdot 7$, respectively. C. A. S.

2877. Molecular structure of NO_2 and HNO_3 by electron diffraction. L. R. MAXWELL AND V. M. MOSLEY. *J. Chem. Phys.*, **8,** *pp.* 738–742, *Sept.*, 1940.—New electron diffraction photographs have been taken of NO_2, extending the region previously investigated to include large angles of scattering. An interference ring was found at $(1/\lambda) \sin \frac{1}{2}\theta = 0 \cdot 49$, followed by another ring appearing at $0 \cdot 94$ as determined by visual measurements. The outer portion of the pattern consists of 2 rather broad rings and 2 well defined minima. Theoretical intensities of scattering were computed for various nitrogen valence angles, assuming the positions of the 2 oxygens to be equivalent. The best fit, and probably the correct structure, gives the angle $O - N - O = 130 \pm 2°$ with the $N - O$ distance $1 \cdot 21 \pm 0 \cdot 02$ Å. Photographs were obtained from pure HNO_3 vapour at 70°–85°C. The interference maxima were measured visually as far out as the 8th maximum at $(1/\lambda) \sin \frac{1}{2}\theta = 1 \cdot 83$; a prominent minimum was seen at $1 \cdot 54$. Theoretical intensities were computed for various likely models, disregarding the scattering by the H atom. Good agreement was obtained for a planar model having a NO_2 group with the same structure as that found for NO. The 3rd oxygen atom O′ is located at a distance of $1 \cdot 41 \pm 0 \cdot 02$ Å from the N atom and equidistant from the other O atoms. A model having the

N atom slightly out of the plane containing the O atoms also gave good agreement with the experimental results. This model, however, is considered less probable in view of Raman spectra data which apparently require a planar structure for $O' - NO_2$. AUTHORS.

2878. Theory of depolymerization of long-chain molecules. E. W. MONTROLL AND R. SIMHA. *J. Chem. Phys.*, **8,** *pp.* 721–727, *Sept.*, 1940.—A theory of depolymerization of long-chain molecules is developed on a statistical basis. It is assumed that all bonds connecting monomeric elements in the system have the same probability of being broken regardless of their position in a given polymer and regardless of the size of the polymer in which they are found. Expressions are derived for the distribution of molecular sizes in the depolymerized system as a function of the initial chain length and the average number of bonds split per molecule. Also, relationships are established between the average molecular weight of the degraded product and the average number of bonds split per molecule. Experiments on the acetolytic degradation of cellulose acetate are briefly discussed. AUTHORS.

2879. Vibration frequencies and thermodynamic functions of long-chain hydrocarbons. K. S. PITZER. *J. Chem. Phys.*, **8,** *pp.* 711–720, *Sept.*, 1940.—A method is developed for calculating thermodynamic functions for long-chain molecules, with particular attention to normal paraffins. In this connection the infinite-chain approximation method for calculating vibration frequencies is considered. Starting with the results of Kirkwood a modification is made which improves the agreement with the exact values for the simpler cases. In addition, this method of attack is extended to out-of-plane motions. This vibrational analysis shows that all skeletal frequencies for molecules of the normal paraffin type can be put into 2 groups, one fairly narrow band near 1 000 cm^{-1}., and a broader band extending from 0 to 460 cm^{-1}. The partition function is then set up on the assumption that motions in the l.f. group can be treated classically, and that the h.f. band can be replaced by a suitable number of 1 000 cm^{-1}. frequencies. Contributions from H-atom vibrations are added later. The calculated entropies can be brought into agreement with experimental values on the basis of reasonable internal rotation-restricting barriers. AUTHOR.

2880. Reaction of hydrogen atoms with butane. E. W. R. STEACIE AND E. A. BROWN. *J. Chem. Phys.*, **8,** *pp.* 734–738, *Sept.*, 1940.—The reaction of H atoms with butane has been investigated over the temperature range 35° to 250°C. The activation energy is 9 ± 1·5 kcal. The products consist solely of methane at low temperatures. At high temperatures ethane is also formed. It is concluded that the results indicate a mechanism in which a series of atomic cracking reactions play the main rôle.

See also Abstracts 2977, 2979, 3028, 3034, 3044.

COLLOIDS.

See Abstracts 2890, 2920, 3030.

CRYSTAL STRUCTURE AND SPECIAL PROPERTIES.

2881. Stability of crystal lattices. Part III. M. BORN AND R. FÜRTH. *Cambridge Phil. Soc., Proc.*, **36,** *pp.* 454–465, *Oct.*, 1940.—[See Abstract 1355 (1940).] The energy density of a cubic lattice, homogeneously deformed by a force acting in the direction of one axis, is calculated, and the equilibrium conditions and the stability conditions for any arbitrary small additional deformations are derived. A special assumption is made as to the law of force between the atoms, and the numerical calculations are performed for the face-centred lattice. In this way the strain as a function of the deformation is calculated and, from the stability conditions, the tensile strength is determined. The results are not in agreement with the experimental facts, and the possible reasons for this disagreement are discussed. Authors.

2882. Stability of crystal lattices. Part IV. M. Born and R. D. Misra. *Cambridge Phil. Soc., Proc.*, **36,** *pp.* 466–478, *Oct.*, 1940.—A method is developed for deriving the higher terms for a cubic lattice of Bravais type in principle to any order. The calculation is carried out in detail for terms of the third order for a law of force which can be expressed as a sum of terms proportional to powers of the reciprocal distance of 2 particles. The mathematical method is an extension of that explained in Part II.

2883. Internal friction of single metal crystals. T. A. Read. *Phys. Rev.*, **58,** *pp.* 371–380, *Aug.* 15, 1940.—The internal friction of crystalline Cu, Sn, Pb and Zn, has been measured by the composite piezo-electric oscillator method. It is found that the decrement of an unannealed crystal may be as large as that of the polycrystalline material, that annealing reduces the decrement to a value of the order 10^{-4} to 10^{-5} and that both Young's modulus and the decrement vary with the vibrational strain amplitude at strain amplitudes as low as 10^{-6}. In the case of Zn crystals a detailed study has been made of the way in which the elastic modulus and internal friction depend on the previous history of the specimen, on the vibration frequency and amplitude and on the orientation of the vibration axis with respect to the crystal slip planes. The results suggest that the mechanism involved is a propagated " dislocation " of the sort proposed by Taylor, Polanyi and Orowan, to account for macroscopic plastic flow and that the application of a stress is accompanied by a plastic strain together with an associated strain hardening in consequence of which the stress/strain relation on removal of the applied stress is nearly elastic. Author.

2884. Internal friction of Al. R. H. Randall and C. Zener. *Phys. Rev.*, **58,** *pp.* 472–473, *Sept.* 1, 1940.—It has previously been pointed out that the nearly elastic isotropy of Al necessitates a very small internal friction. By making measurements over a range of grain size and of frequency it is established that the internal friction of Al is less than 1/10 of that of α-brass under corresponding conditions. Authors.

2885. Light figures in single crystals of Ni and Cu. M. Yamamoto. *Tohoku Univ., Sci. Reports*, **19,** *pp.* 113–131, *June*, 1940. *Report No.* 473 *of the Research Inst. for Iron, Steel and other Metals.*—Light figures were observed on the 3 principal crystal planes (100), (110) and (111), of single crystals of Ni and Cu, which were etched for different time-intervals with aqueous solutions of various concentrations of acids and salts, and their suitability for determining the orientation of the metal crystals with the method of light figures is examined. Author.

2886. Equilibrium solid solutions in ionic lattices. A. L. Greenberg and G. H. Walden, Jr. *J. Chem. Phys.*, **8,** *pp.* 645–658, *Sept.*, 1940.—The systems $KMnO_4$-$KClO_4$-H_2O and NH_4Cl-$MnCl_2$-H_2O have been studied at equilibrium conditions by phase-rule and X-ray diffraction methods. The first system yields a continuous series of solid solutions having orthorhombic crystal symmetry. For these, the components of which are of similar crystal and chemical structure and of identical valence type, Vegard's additivity law is followed by the a_0 and c_0 lattice constants, but the b_0 constant shows a definite deviation. A method is described of obtaining homogeneous crystals with a particle size which gives excellent powder diffraction photograms in cases where heat annealing is not feasible. A method of analysing for ClO_4^- is given. The system NH_4Cl-$MnCl_2$-H_2O shows 3 solid-solution series; the crystals obtained in the first series have cubic symmetry, while in the others the symmetry is tetragonal. The mechanism of the formation of the "anomalous" solutions between NH_4Cl and $MnCl_2$ is given. It is shown that Vegard's law is not followed by the first solid-solution series in which the components are of dissimilar chemical and crystal structure and dissimilar valence types. The curve for the relationship between the lattice constants and composition rises to a maximum and then falls off. The existence of a new "compound," $6NH_4Cl \cdot MnCl_2 \cdot 2H_2O$, is demonstrated. This and the known compound, $2NH_4Cl \cdot MnCl_2 \cdot 2H_2O$, are considered to be examples of compounds of variable composition. They are tetragonal with $a_0 = 15 \cdot 256 \pm 0 \cdot 004$ Å, $c_0 = 16 \cdot 008 \pm 0 \cdot 007$ Å and $a_0 = 7 \cdot 5139 \pm 0 \cdot 0005$ Å, $c_0 = 8 \cdot 245 \pm 0 \cdot 003$ Å, respectively. The structure of the latter is that of $2NH_4Cl \cdot CuCl_2 \cdot 2H_2O$ which belongs to space group $D_4^{14}h$ or *P4mnm*. AUTHORS.

2887. Crystal-structure models for close-packed systems. D. B. LANGMUIR AND R. B. NELSON. *Rev. Sci. Instruments*, **11**, *pp*. 295–297, *Sept.*, 1940.

See also Abstracts 2891, 2973, 2985, 2996, 3028.

ELASTICITY AND PLASTICITY.

2888. Relation between the elastic constants for natural stones. R. H. EVANS. *Leeds Philosoph. and Lit. Soc., Proc.*, **3**, *pp*. 593–596, *July*, 1940. —The relation between the elastic constants for the natural stones granite, sandstone, marble and slate, are determined by testing the same specimen in tension, compression and torsion. The results show that the elastic constants satisfy the equation $E = 2N(1 + 1/m)$, this being the theoretical relation between the elastic constants in a perfectly elastic material. The modulus of rigidity for stones may therefore be calculated from the elastic constants in either tension or compression. In the case of fibrous materials, such as wood, the results indicate that the modulus of rigidity cannot be estimated from the tensile or compressive results and that in such cases the rigidity modulus can only be determined by testing a specimen in torsion. AUTHOR.

2889. Instantaneous strains in building materials. R. H. EVANS. *Leeds Philosoph. and Lit. Soc., Proc.*, **3**, *pp*. 584–592, *July*, 1940.—The stress/strain curves for sandstone, concrete and granite, are recorded under rapidly applied loads after the materials have been brought first into a state of ease by either repeated loadings or sustained stress. The strain is afterwards entirely elastic and a series of experiments can be made to investigate the possibility of reducing the amount of elastic time strain present in the immediate strain by gradually increasing the loading speed. Special apparatus, operated by compressed air, is constructed to apply loads up to 15 tons in at least 0·01 sec. Extensometers are also designed to enable records to be taken of the rapid strains on films placed on rotating drums. The results obtained show quite definitely that the immediate strain in these materials diminishes as the rate of loading increases and that, in the case of sandstone, the percentage reduction of the elastic time strain, when the load is applied in 0·0097 sec., is 38. The immediate strain curve therefore gradually approaches the short-range integral strain curve as the loading speed is increased, indicating that the latter represents the true instantaneous strain curve for materials exhibiting time strains. It is estimated that loading speeds of the order 0·002 sec. are required before the immediate strain and the short-range integral strain curves will sensibly coincide. AUTHOR.

2890. Effect of humidity and temperature on Young's modulus of keratin fibres. H. J. WOODS. *Leeds Philosoph. and Lit. Soc., Proc.*, **3,** *pp.* 577–583, *July*, 1940.—Using high rates of extension within the Hooke's law region of the load/extension curve a series of measurements of Young's modulus can be made with a single fibre. For humidity changes the results agree with Speakman's statistical values; the water adsorbed at low humidities has less effect than the remainder in reducing Young's modulus. The temperature effect for all types of hair is small compared with the large temperature variation of relaxation phenomena. For dry fibres the temperature coefficient of Young's modulus between 0° and 100°C. is of the order $-2{\cdot}5 \times 10^{-3}$ per deg., and a somewhat similar value is obtained for wet fibres between 40° and 90°C. Usually, particularly with human hair, Young's modulus for wet fibres decreases much more rapidly as the temperature rises to 40°C. than above this temperature. AUTHOR.

2891. Temperature dependence of Young's modulus of β-brass single crystals. J. S. RINEHART. *Phys. Rev.*, **58,** *pp.* 365–371, *Aug.* 15, 1940.—Young's modulus of 7 single crystals of β-brass has been measured as a function of temperature from 25°. to 505°C. for the purpose of studying the order-disorder phenomenon. The method used is that of the composite piezo-electric oscillator. The reciprocal of Young's modulus is linearly related to the orientation function at all temperatures. The maximum and minimum values of the reciprocal of Young's modulus, $1/E_{(100)}$ and $1/E_{(111)}$, are 3·881 and $0{\cdot}475 \times 10^{-12}$ at room temperature and 4·970 and $0{\cdot}583 \times 10^{-12}$ cm^2./dyne at the critical temperature (468°C.). The elastic anisotropy, given by $E_{(111)}/E_{(100)}$, has the value 8·2 at room temperature, decreases to a minimum, 7·2, at 300°C., and again increases to 8·6 at the critical temperature. Plots of the reciprocal of Young's modulus in 3 principal directions, [100], [110] and [111], show that the effect of disorder is mainly felt in the first 2 directions while in the third direction the elasticity shows an approximately linear increase with increasing temperature. Before disorder sets in the elasticity in the [100] direction decreases with increasing temperature, contrary to the usual behaviour of elastic materials. AUTHOR.

2892. Theory of large elastic deformation. M. MOONEY. *J. of Applied Physics*, **11,** *pp.* 582–592, *Sept.*, 1940.—It is postulated that the material is isotropic, the volume change and hysteresis are negligible and the shear is proportional to the traction in simple shear in a plane previously deformed, if at all, only by uniform dilatation or contraction. It is deduced that the general strain/energy function, W, has the form $W = \tfrac{1}{4}G\sum_{i=1}^{3}(\lambda_i - 1/\lambda_i)^2 + \tfrac{1}{4}H\sum_{i=1}^{3}(\lambda_i^2 - 1/\lambda_i^2)$, where the λ_i's are the principal stretches

(1 + principal extension), G is the modulus of rigidity and H is a new elastic constant not found in previous theories. The differences between the principal stresses are $\sigma_i - \sigma_j = \lambda_i \partial W / \partial \lambda_i - \lambda_j \partial W / \partial \lambda_j$. Calculated forces agree closely with experimental data on soft rubber from 400% elongation to 50% compression. AUTHOR.

2893. Effects of a change of Poisson's ratio analysed by twinned gradients. H. M. WESTERGAARD. *J. of Applied Mechanics*, **7**, *A*113–*A*116, *Sept.*, 1940.—Some problems of elasticity have a simple solution for a particular value of Poisson's ratio. For example, Boussinesq's problem of a normal force and Cerruti's problem of a tangential force acting on the plane surface of a semi-infinite solid are solved when Poisson's ratio is ½ by referring to Kelvin's problem of a force at a point in the interior of an infinite solid. For, when Poisson's ratio is ½, the solution of Kelvin's problem can be stated in terms of 1 principal stress at each point, acting along the radial line from the point of the load; the other principal stresses are zero; and ½ of the total force may be assigned to ½ of the infinite solid. For other values of Poisson's ratio terms must be added in the formulae for the displacements and stresses. The derivations that have been available are somewhat lengthy, especially for Cerruti's problem. The difficulties are reduced by a simple analytical device, here called the twinned gradient. The displacement to be added by the change of Poisson's ratio is stated as the gradient of a potential except that one of the components is replaced by its twin, an identical component in reversed direction. This device also lends itself to a simplification of the analysis of stresses in a rotating thick disc. AUTHOR.

GRAVITATION.

***2894. Calibration of astatic gravimeters.** G. ISING. *Arkiv f. Mat. Astron. och Fysik, Stockholm*, **27A**, 4, [13 *pp*.], 1940. *In German*.—An expression for the sensitivity of an astatic gravimeter is deduced, and it is shown that such an instrument can be calibrated in the laboratory to an accuracy of 0·5%. A. J. M.

HYDRODYNAMICS AND AERODYNAMICS.

2895. Generalization of Cunningham's extension of Stokes's law for the force on a sphere. G. YOUNG. *Math. Biophysics, Bull.*, **2**, *pp*. 105–108, *Sept.*, 1940.—Cunningham's formula for the force on a sphere moving within a larger concentric spherical boundary is extended to cover a general state of motion of the fluid between them. AUTHOR.

2896. Forces on 2 parallel infinitely long plane plates placed in uniform flow. Y. NOMURA. *Tohoku Univ., Sci. Reports*, **19**, *pp*. 22–35, *June*, 1940.—Discusses the irrotational liquid flow past 2 fixed parallel strips whose central lines are coplanar and perpendicular to the flow. The velocity potential is expressed as a series of integrals involving Bessel functions, and equations for the coefficients are found in terms of the boundary values with the help of hypergeometrical polynomials. The solution of these is determined numerically by iteration in the case of equal strips. The force and couple acting on each strip are calculated for several distances between 2 strips and these results are compared with those of 2 equal circular discs which were obtained in the previous paper [Abstract 1395 (1940)]. AUTHOR.

2897. Flow of a compressible fluid past a sphere. K. Tamada. *Phys. Math. Soc. Japan, Proc.*, **22,** *pp.* 519–525, *July*, 1940.—The theoretical results obtained in a previous paper [Abstract 1394 (1940)] are compared with the experimental results of Pasqualini, who found that, when the Mach number $M = U/c_0$ exceeds the value 0·55 approximately, the drag of a sphere increases considerably ; U is the speed of the sphere and c_0 the speed of sound associated with the undisturbed flow of air moving with velocity U. This value compares with the theoretical value 0·574 obtained for the so-called critical Mach number M_c at which the local speed of sound is first attained in the field of flow. Agreement between theoretical and experimental results is satisfactory. Some tentative applications of the theoretical results are made to the effect of rivet heads and surface roughness upon the drag of high-speed aeroplanes when the compressibility of the air must be taken into account. Author.

2898. Non-permanent movement of viscous liquids in tubes of very small diameter. K. Kitagawa. *Phys. Math. Soc. Japan, Proc.*, **22,** *pp.* 442–447, *June*, 1940. *In French.*—A mathematical discussion of the movement occurring in the absence of external forces. A. J. M.

2899. Flow of suspensions through narrow tubes. F. J. Dix and G. W. S. Blair. *J. of Applied Physics*, **11,** *pp.* 574–581, *Sept.*, 1940.—The anomalous flow of certain suspensions through narrow tubes, known as the σ phenomena, for which no fully satisfactory explanation has yet been given, is discussed. If it be assumed that the streamlining layers are not infinitely thin, so that a summation treatment takes the place of an integration, a series of equations can be derived depending on the relation assumed to exist between velocity gradient and shearing stress and on the nature of the friction between the layers. These equations reduce, in the limiting case of infinitely thin layers, to the well-known forms. For the finite thicknesses of layer the equation derived adequately explains the σ-phenomenon, and this is shown quantitatively by applying it to the data given in the original paper. Authors.

KINETIC THEORY OF MATTER.

See Abstract 2977.

MATHEMATICAL METHODS AND THEORY OF MEASUREMENTS.

2900. Operator calculus in the electron theory of metals. K. Fuchs. *Roy. Soc., Proc. A*, **176,** *pp.* 214–228, *Oct.* 9, 1940.—An operator calculus is developed applicable to problems in the electron theory of metals. It differs from the common operator calculus of the quantum theory in the fact that the wave function is defined in a finite space (the atomic polyhedron) bounded by a finite surface. This leads to the introduction of surface operators. The position operator $\mathbf{x}$ cannot be developed with respect to the proper functions of the Hamiltonian. Instead an operator ξ is introduced, which is essentially the Fourier development of $\mathbf{x}$. Thus there are 3 fundamental types of operators : the differential operator $\mathbf{p}$, the multiplication operator ξ and the surface operators. It is shown that with the help of these a consistent calculus can be developed. Author.

2901. Fermi-Dirac functions. J. L. B. Cooper. *Phil. Mag.*, **30,** *pp.* 187–189, *Sept.*, 1940.—The asymptotic expansion and some other properties of these functions are obtained by a simplified method which employs the Laplace transform. G. C. McV.

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2902. Notes on Mathieu functions. Part I. A class of hyperbolic Mathieu functions. W. G. BICKLEY. *Phil. Mag.*, **30**, *pp.* 312–322, *Oct.*, 1940.

MECHANICS, CLASSICAL.

See Abstract 2912.

MECHANICS, QUANTUM.

2903. Classical theory of exchange forces. E. C. G. STUECKELBERG AND J. F. C. PATRY. *Helv. Phys. Acta*, **13**, 3, *pp.* 167–192, 1940. *In French.*—The meson theory of nuclear forces is studied in the "classical" approximation, i.e. neglecting the quantum fluctuations in the meson field. The question investigated is whether the "scalar" interaction potential, which is the mathematical analogue to Coulomb's force, represents a sufficient approximation. It is found that this scalar term is the first term in a series expansion of which the higher terms are not negligible, but which converges satisfactorily in a theory in which the meson has no spin. In the more important case of a meson with one unit of spin the convergence is too slow to be of any practical use. R. P.

2904. Invariance of the Dirac wave equations with respect to similarity transformations of the line elements in the case of very small stationary masses. W. PAULI. *Helv. Phys. Acta*, **13**, 3, *pp.* 204–208, 1940. *In German.*

2905. Statistical mechanics of assemblies whose energy levels depend on the temperature. G. S. RUSHBROOKE. *Faraday Soc., Trans.*, **36**, *pp.* 1055–1062, *Oct.*, 1940.—The well known formalism of statistical mechanics is extended to apply to assemblies for which the permissible energy levels depend on the temperature. If an energy E, occurring in a partition function, depends on the temperature, then the corresponding Boltzmann factor $e^{-E(T)kT}$ must always be replaced by $e^{-F(T)kT}$, where $F(T)$ is the Helmholtz free energy related to $E(T)$ by a Gibbs-Helmholtz relation. This is necessary in order that the statistical scheme may conform to the demands of thermodynamics. AUTHOR.

See also Abstracts 2988, 3000.

PHILOSOPHY OF SCIENTIFIC METHOD.

See Abstract 2911.

PRESSURE.

***2906. Differential liquor manometer of high sensitivity, founded on O. Pettersson's theory of submarine waves.** P. SEDERHOLM AND C. BENEDICKS. *Arkiv f. Mat. Astron. och Fysik, Stockholm*, **27A**, 8, [5 *pp.*], 1940.—Using a conception of Pettersson regarding submarine equilibrium, a differential manometer of great sensitivity has been designed. The instrument, using 2 immiscible liquids of nearly the same spec. gravity, is considerably simpler than a similar instrument described by Gramberg (1926). AUTHOR.

***2907. Oil vacuum gauge.** H. WAKESHIMA. *Phys. Math. Soc. Japan, Proc.*, **22**, *pp.* 525–528, *July*, 1940.—A new type of oil vacuum gauge equipped with a specially designed compressing chamber is devised, in which the mercury trap can be avoided. Due to the small density of oil lower pressures can be measured, but the gauge cannot be used when the pressure of gas is rapidly changing. AUTHOR.

***2908. Recording optical manometer for transient pressures.** P. B. Smith. *Journ. Sci. Instruments*, **17**, *pp.* 242–245, *Oct.*, 1940.—This paper describes a manometer capable of being used to record pressures caused by the explosion of gaseous mixtures in vessels totally or partially closed. Permanent records are obtained as time/deflection graphs on a light-sensitive film (bromide paper). The maximum deflection available is approximately 4 cm. and the range of pressures which can be made to correspond with this deflection is capable of wide variation. The natural frequency of the recording system (in which there are no loose-coupled parts) is high and is an inverse function of the sensitivity. Author.

***2909. Comparative study of water aspirators.** E. P. Little and S. E. Pond. *Rev. Sci. Instruments*, **11**, *pp.* 285–286, *Sept.*, 1940.—The relative speed of evacuation, water consumption, air pumping ability and final vacuum, produced by 14 water aspirators, have been measured.

***2910. Baffles for oil diffusion pumps.** R. S. Morse. *Rev. Sci. Instruments*, **11**, *pp.* 277–281, *Sept.*, 1940.—Although in the use of oil diffusion pumps for the production of high vacuum extremely cold traps in the usual sense are not required, some means must be provided to prevent both direct backstreaming and diffusion of the oil vapour. The relative advantages of (1) charcoal traps, (2) cold traps, (3) hot baffles, (4) electrical baffles, (5) mechanical baffles, are discussed and specific designs for effective high-speed baffles are given. Author.

RELATIVITY AND ETHER.

2911. The rate of a moving clock. H. Dingle. *Nature*, **146**, *pp.* 391–393, *Sept.* 21, 1940.—The author replies to correspondence connected with a previous article [Abstract 342 (1940)] in which it was maintained that there is no foundation for the statement that the rate of a moving clock is reduced by a certain factor compared with that of a similar stationary clock. It is stated that the result of comparison between the stationary and moving clocks is quite unpredictable without an exact specification of the principle of operation or detailed mechanism of the clock. The experimental discovery of the dependence of length on velocity affects the whole of physics, and its effect is to show that certain conceptions thought to be independent and necessary are actually different forms of others already adopted. These results in no way remove the dependence of laws of physics on experience. J. S. G. T.

SOLUTION.

See Abstract 3003.

SURFACE PROPERTIES.

2912. Theoretical isotherms for adsorption on a square lattice. L. Tonks. *J. Chem. Phys.*, **8**, *pp.* 477–489, *June*, 1940.—The method used by Roberts [Abstract 4815 (1938)] and others to calculate isotherms of gases adsorbed on surfaces with regular sites, throughout the full range from small covering of the surface to complete saturation, is criticized on the grounds that the approximation in which this method is usually applied does not give reasonable results in some cases in which it might be used. From this it is concluded that the more rigorous equations must be used which are easily obtainable in the limiting cases of a nearly empty and a nearly covered surface, but not in the intermediate region. R. P.

2913. Application of the theory of absolute reaction rates to heterogeneous processes. Part I. The adsorption and desorption of gases. Part II. Chemical reactions on surfaces. K. J. Laidler, S. Glasstone and H. Eyring. *J. Chem. Phys.*, **8**, *pp.* 659–667, *Sept.*, 1940.—By regarding the process of adsorption as involving a reaction between a molecule of gas and an adsorbing centre on the solid surface, it has been possible with the aid of the theory of absolute reaction rates to derive for the rates of adsorption and desorption of gases simple equations which can be tested experimentally. Different results are obtained according as the adsorbed gas forms an immobile or a mobile layer on the surface: in the latter circumstance, which does not appear to be common, the rate of adsorption would be given by the Hertz-Knudsen equation, provided there were no activation energy for adsorption. Combination of the expressions for the rates of adsorption and desorption gives an adsorption isotherm of the same form as that originally derived by Langmuir. Various cases of adsorption accompanied by dissociation of the adsorbed molecule are considered and the appropriate rate equations are deduced. If the molecule undergoes dissociation in the course of adsorption and the atoms remain on neighbouring sites, these equations and the isotherm are the same as if there had been no dissociation, but if the molecule is adsorbed as such and then dissociation occurs as the result of an atom jumping from one adsorption centre to another, the rate equations and isotherm differ from those obtained previously. The isotherm involves $p^{\frac{1}{2}}$ instead of p, but the form of the rate equation depends on whether the adsorption of the molecule or the jump of the atom is the slow stage. The possibility of interaction between adsorbed atoms or molecules in an immobile film on the surface is considered, and a modified isotherm which makes allowance for such interaction is derived. Equations have also been deduced for adsorption on covered surfaces. The method is used to derive equations for the rates of unimolecular and bimolecular heterogeneous gas reactions under various conditions of surface coverage by either reactants or poisons. The resulting equations are of the same form as those previously deduced by Langmuir and others, but they are more explicit; provided the activation energy is known, they can be utilized to calculate rates of surface reactions which are in good agreement with the observed values. In the case of the dissociation of hydrogen on a tungsten surface, the simple assumption that the activated state consists of hydrogen atoms permits the absolute rate of the reaction to be calculated with an accuracy which is at least as good as that attained by direct experimental measurement. The factors responsible for the difference in rates of the same reaction taking place homogeneously or heterogeneously are considered; it is shown that adsorption of the activated complex lowers the overall activation energy, and this has the most important influence in favouring the surface reaction. If one of the products, or any other substance acting as a poison, is strongly adsorbed, the effective activation energy is increased, but there is some compensation resulting from the increase of entropy accompanying the desorption of the poison.

Authors.

***2914. Interferometer method for measuring absolute adsorption in the surface of solutions.** J. W. McBain, G. F. Mills and T. F. Ford. *Faraday Soc., Trans.*, **36**, *pp.* 930–935, *Sept.*, 1940.—If the surface of a solution is destroyed or submerged, the solute adsorbed in it must be dissolved in the bulk of the liquid. If this operation can be made to take place in the light path of an interferometer, the change in concentration may be observed as a deflection of interference fringes. This method has been used successfully with solutions of hydrocinnamic acid and lauryl sulphonic acid, the results obtained agreeing satisfactorily with those predicted from the Gibbs theorem, and with those obtained by the microtome method. The construction of the interferometer cell is described.

A. J. M.

2915. Measurement of the linear tension at the boundary liquid/liquid/air. R. S. Bradley. *Faraday Soc., Trans.*, **36,** *pp.* 999–1003, *Sept.*, 1940.—The linear tension at liquid/liquid/air boundaries was determined by making accurate measurements of the diameter and thickness at the centre of large lenses of one liquid floating in another. Observations are recorded for oleic acid in H_2O, and in solutions of various *p*H. A. J. M.

2916. Molecular interactions at oil/water interfaces. Part III. Interfacial tension measurements. A. E. Alexander and J. H. Schulman. *Faraday Soc., Trans.*, **36,** *pp.* 960–964, *Sept.*, 1940.—In Parts I and II [Abstract 2350 (1940)] it was shown how the existence and stability of certain oil-in-water (O/W) and water-in-oil (W/O) types of emulsions could be accounted for, and a description is now given of benzene/water interfacial tension (I.T.) measurements for certain systems which give O/W and W/O types of emulsions. In the O/W type, where the water-soluble agent was sodium dodecyl sulphate, the order of lowering of I.T. by oil-soluble agents was cholesterol, octadecyl alcohol and elaidyl alcohol (approximately the same) > oleyl alcohol > cholesterol myristate. In the W/O type, where the water-soluble agent was heptadecylamine hydrochloride, inversion by the agents sodium sulphate and sodium trimetaphosphate was found to be accompanied by solidification of the originally liquid interfacial film. These results were in agreement with earlier conclusions drawn from experiments at the air/water interface and from emulsions. It is suggested that solid stabilizing agents can be incorporated into the same scheme. H. H. Ho.

***2917. Thickness of a liquid film adhering to a surface slowly withdrawn from the liquid.** F. C. Morey. *Bureau of Standards, J. of Research*, **25,** *pp.* 385–393, *Sept.*, 1940.—When a solid body is immersed in a bath of liquid and withdrawn, a film of the liquid adheres to the solid surface and gradually drains back into the bath when the motion ceases. The relationship existing between the average film thickness, the speed of withdrawal and the kinematic viscosity of the liquid, is dealt with. According to the generally accepted theory the film thickness varies as $\sqrt{(\text{speed} \times \text{kinematic viscosity})}$. It was noticed that corrections based on this relationship and used in the calibration of a gas-measuring standard were not satisfactory. An experimental apparatus was designed to test the theory. Analysis of the data revealed that, within the range of speeds used, the theory does not correctly predict the film thickness, and an empirical equation of the form $t = k\,(\nu s)^n$ was employed, in which t is the average film thickness, ν is the kinematic viscosity of the liquid, s is the speed of withdrawal of the surface, k and n are quantities varying slightly with the liquid used. The approximate values of k and n found by experiment are 0·015 and 0·63, respectively. Nine liquids were tested, including mineral, vegetable and animal oils, and synthetic organic compounds of oily nature. Author.

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2918. Oiliness of liquids. T. Isemura. *Chem. Soc. Japan, Bull.*, **15,** *pp.* 288–291, *Aug.*, 1940.—[See Abstract 3918 (1939).] The measurements of the static friction coefficients of cyclic compounds for glass surfaces are reported. It is noticed that no cyclic compound is a good lubricant; however, among them *m*-cresol and cyclohexanol are moderately active as lubricants. Author.

See also Abstracts 2890, 3003.

TIME.

See Abstract 2911.

VISCOSITY AND FRICTION.

2919. Rough measurement of high viscosities. H. C. Pocklington. *Cambridge Phil. Soc., Proc.*, **36,** *pp.* 507–508, *Oct.*, 1940.

2920. Viscosity of suspensions in non-aqueous liquids. E. W. J. Mardles. *Faraday Soc., Trans.*, **36,** *pp.* 1007–1017, *Oct.*, 1940.—Viscosity measurements have been made, avoiding low rates of shear, of suspensions of kaolin, graphite and other solids, over a wide range of concentration, in several organic liquids. The ratio η/η_0, where η is the viscosity of the suspension and η_0 the viscosity of the dispersion medium, varies with the latter value, being relatively high for viscous liquids such as glycerol and low for liquids of low viscosity such as normal hexane. The ratio decreases with rising temperature and consequent fall in the viscosity of the dispersion medium. Although with graphite in liquids of low viscosity the data obtained at low concentrations approached those in accord with the Einstein equation $\eta = \eta_0 (1 + 2{\cdot}5\,V)$, yet with kaolin in a light mineral oil or mica in alcohol, for example, approximately 4 times the theoretical values were obtained at low concentrations. Anomalous viscosity was found to be less pronounced with suspensions in viscous liquids than in those of low viscosity. With different solids in one dispersion medium large variations were found, the viscosity being low for graphite and high for silica. Viscosities of suspensions, higher than the theoretical, appear to be due mainly to the disturbance of laminar flow by the precessional movement and the mutual interference of the dispersed particles, alone or in aggregates. Differences in viscosity behaviour of suspensions in viscous and thin liquids are ascribed to the more sluggish rotational movement of the particles in viscous liquids than in liquids of low viscosity. Author.

ASTRONOMY AND ASTROPHYSICS.

COMETS AND METEORS.

2921. Probability of occurrence of hyperbolic cometary orbits. Part II. M. Taalimi. *Arch. des Sciences*, **22,** *pp.* 105–146, *May–June*, 1940.—[See Abstract 2592 (1940).] The author concludes his investigation into the character of cometary orbits at great distances from the solar system. The main difficulty is the perturbations introduced into the observable part of the orbit by the attraction of Jupiter. The rarity of hyperbolic orbits is not an insuperable objection to the theory of interstellar origin: by the author's hypothesis the bodies originate in interstellar space at a considerable distance from the sun, yet not so far that the sun's attraction is outweighed by that of the other stars; 4 or 5 orbits per 1 000 retain their hyperbolic character within the solar system. A. Hu.

NEBULÆ.

2922. Evolution of extragalactic nebulae. G. Randers. *Mt. Wilson Observat., Contrib. No.* 634. *Astrophys. J.*, **92,** *pp.* 235–246, *Sept.*, 1940.—The great variety of types of extragalactic nebulae which differ fundamentally from both spiral and elliptical nebulae indicates that the current theories of the formation of spiral arms by ejection of matter from rotating elliptical nebulae are not sufficient for an explanation of nebular evolution. Especially striking is the tendency, found rather frequently among all types of nebulae, to form a circular ring or a system of rings. It is suggested that the ring formation may be an important step in the evolution and that the active agent in this process is viscosity in a differentially rotating system. Author.

2923. Clustering tendencies among the nebulae. E. Holmberg. *Mt. Wilson Observat., Contrib. No.* 633. *Astrophys. J.*, **92,** *pp.* 200–234, *Sept.*, 1940.—Part I gives an investigation of double and multiple nebulae contained in the General Catalogue. An analysis of the distribution of angular distances between nebulae results in a statistical separation of physical and optical companions; double and multiple systems are revealed as they actually exist in the sky. The average distances between physically connected nebulae appear to be considerably larger than those previously assumed. In Parts II–IV possible interpretations of the clustering tendencies are discussed. Double and multiple systems as well as clusters may be explained as a result of captures between nebulae, effected by tidal forces at close encounters. A summary of the main conclusions is given. Author.

See also Abstract 2928.

STARS.

2924. HD 167 362, an object similar to Campbell's hydrogen envelope star. P. Swings and O. Struve. *Nat. Acad. Sci., Proc.*, **26,** *pp.* 454–458, *July*, 1940.—The nucleus of this star is a Wolf-Rayet carbon star of type WC9 in which originate the broad lines of He II, C III, C IV and O III. The nucleus is surrounded by a nebula which gives rise to the following forbidden lines: [N II], [O II], [O III], [S III], [O I]. The lines of He I and H belong to both the central star and the nebula. The spectrum of the star as a whole consists of a weak continuum with maximum intensity near λ4 300, with superimposed strong, bright lines. The measured lines are listed. G. C. McV.

2925. Spectrum of RW Hydrae. P. Swings and O. Struve. *Nat. Acad. Sci., Proc.*, **26,** *pp.* 458–461, *July*, 1940.—The star is an abnormal long-period variable with a range of one magnitude. A list of the emission lines is given, including 14 permitted lines of O III between λ3 265 and λ3 962. The star is a binary consisting of a late-type star with a companion of high excitation. The excitation of the nebular part is rather similar to R Aquarii. The two components have about equal radial velocities of + 15 km./sec. G. C. McV.

2926. Accidental and systematic errors in spectroscopic absolute magnitudes for dwarf Go-K2 stars. G. Strömberg. *Mt. Wilson Observat., Contrib.* No. 628. *Astrophys.* J., **92,** *pp.* 156-169, *Sept.,* 1940.—The errors in the spectroscopic absolute magnitude (M_s) for dwarf stars of spectral types G0–K2 have been studied to determine the regression lines and the mean errors in the individual values of M_s. The stars were grouped according to the reduced proper motion $H = m + 5 \log \mu$, which is correlated with the true absolute magnitude (M). Trigonometric parallaxes were used to determine values for the mean and the dispersion in M. The two regression lines were determined, and the proper corrections to M_s were derived for 2 cases : the stars are selected or grouped (1) on a basis directly connected with M itself, (2) on a basis directly connected with the special spectral features which define M_s for a given spectral interval. The mean errors of M_s as published have been found to be 0·51 for the G0–G7 stars and 0·75 for the G8–K2 stars. After the corrections have been applied the mean errors for the 2 spectral groups are 0·41 and 0·49, respectively, when the stars are grouped according to M_s, and 0·60 and 0·65, respectively, when the stars are grouped according to M itself.
Author.

2927. Transition probabilities of forbidden lines. S. Pasternack. *Astrophys. J.,* **92,** *pp.* 129–155, *Sept.,* 1940.—The calculation of transition probabilities of forbidden lines is discussed for atoms in the p^2, p^3, p^4, d^2 and d^3 configurations. The results of numerical computations are given for a large number of elements in the p^4 configurations, for the d^2 configuration of Fe vii, and for the d^3 configuration of Cr iv, Mn v and Fe vi. Some implications of the results are mentioned. Author.

2928. Spectrum of NGC 6543 and its nucleus. P. Swings. *Astrophys. J.,* **92,** *pp.* 289–294, *Sept.,* 1940.—In the nebula NGC 6543 Bowen's fluorescence mechanism is absent and the recombination process is especially efficient, giving relatively strong lines of C ii, C iii and N iii. The nucleus is a Wolf-Rayet star showing lines of N iv and C iv of similar intensities ; it is thus an object intermediate between the WN and WC sequences. Author.

2929. Nebular spectra of 2 slow novae DQ Herculis and RT Serpentis. P. Swings and O. Struve. *Astrophys. J.,* **92,** *pp.* 295–302, *Sept.,* 1940.—The spectrum of Nova Herculis has been measured in the region λλ 3200–6700, and many new lines have been identified. The character of the spectrum has not changed greatly since the observations by Adams and Joy in 1935–1936, but the increased separation between the 2 visual components of the Nova has now made it possible to observe separately the 2 spectra. The ionization seems to be identically the same in the 2 objects, but some differences in the structure of the lines were noticed. Spectra taken with the slit along the major axis of the elongated image show a marked depression between the 2 outside components of the emission lines, while at least the preceding component of the binary shows a fairly strong central component between the 2 outside components. The observations are sensitive to conditions of seeing, and it is not possible at this stage to unravel the true nature of the spectroscopic structure of the lines. The spectrum of Nova Serpentis, which had an outburst in 1909 and which is known to have developed abnormally slowly, was last described by Joy in 1931. Since that time the spectrum has undergone marked changes : the lines of [Fe iii], which were strong in 1931, are very weak. Instead, [Ne III], [Ne V] and [Fe VI] are strong, in addition to H, He I, He II, and [O III]. AUTHORS.

2930. Possible existence of formaldehyde in the atmosphere of Venus. R. WILDT. *Astrophys. J.*, **92,** *pp.* 247–255, *Sept.*, 1940.—Ultra-violet spectrograms of Venus and of the moon, for comparison, were obtained with the long-focus quartz spectrograph (dispersion 21·7 Å/mm. at λ 3300) attached to the 82 in. reflector of the McDonald Observatory in order to search for the electronic absorption spectrum of formaldehyde gas which might be formed in Venus's atmosphere by photochemical synthesis. The spectrograms revealed no sign of absorption by CH_2O, while a mass of this gas equivalent to 3 mm. atm. under standard conditions should have been sufficient for spectroscopic identification. This negative result does not refute the assumption that the photochemical formation of CH_2O has played an importal rôle in Venus's atmosphere during the past. In the light of Tammann's theory of the origin of the terrestrial oxygen, the lack of oxygen on Venus indicates that the primordial atmosphere of this planet must have been extremely poor in water vapour. A tenuous atmosphere of water vapour and CO_2 affords the very conditions for the photochemical synthesis of formaldehyde, which appears to be capable of proceeding until the supply of either of these gases has been exhausted. In a moist atmosphere CH_2O rapidly polymerizes into a mixture of polyoxymethylene hydrates, $(CH_2O)_x \cdot H_2O$, a white crystalline solid. From laboratory data it is concluded that the amount of gaseous CH_2O existing in equilibrium with the solid polymers is exceedingly small, which would seem to account for the failure of the spectroscopic test. The vapour tension of the solid polymers in the presumable range of Venus's atmospheric temperature is high enough to permit the dissolution and formation of clouds by processes of sublimation and subsequent condensation. As Venus's atmosphere is now spectroscopically free from water vapour but is obviously filled with clouds, the nature of which has never been settled, it is tentatively suggested that solid polyoxymethylene hydrates constitute the clouds shrouding the planet's surface. AUTHOR.

2931. Physical aspects of accretion by stars. F. HOYLE AND R. A. LYTTLETON. *Cambridge Phil. Soc., Proc.*, **36,** *pp.* 424–437, *Oct.*, 1940.—[See Abstract 4249 (1939).] The presence of H_2-molecules reduces the temperature of the cosmical cloud to a value that is small compared with the estimate given by Eddington. The necessary conditions for the molecules to persist at the capture radius of hot stars are investigated in the present paper, and it is shown that provided the density of the cosmical cloud is sufficiently high the molecules will not suffer appreciable dissociation, and that radiation pressure will have only a negligible effect on the hydrogen. The critical density for a typical *B* star appears to be about 5×10^{-21} gm./cm³. AUTHORS.

2932. Galactic clusters NGC 6649 and NGC 6694. J. CUFFEY. *Astrophys. J.*, **92,** *pp.* 303–314, *Sept.*, 1940.—Red colour indices have been obtained for 528 stars in and near the heavily obscured galactic clusters NGC 6649 and NGC 6694 in Scutum. The relations between colour and apparent magnitude show that NGC 6694 contains a well defined main sequence and a slight indication of a giant branch. For NGC 6649 the colour-magnitude diagram resembles that of h and χ Persei or of Messier 7, shifted to the red by $1^{m}65$. A zone of low star density 3′ from the centre of NGC 6694 is noted. The colour excesses (λλ 4300–6200) and distance moduli derived are: NGC 6649, $1^{m}65$ and $12^{m}1$; NGC 6694, $0^{m}55$ and

$11^{\mathrm{m}}1$. The ratio between general and selective absorption is estimated from the available data on red colour indices in obscured clusters. Although uncertain in many cases, the results tend to confirm the ratio $A_r/(A_b - A_r) = 2$, predicted by the $1/\lambda$ law of scattering. The moduli for NGC 6 649 and NGC 6 694 have accordingly been corrected for the general red absorption, and the distances are 570 and 1 000 parsecs. respectively. AUTHOR.

2933. Galactic rotation and absorption. R. E. WILSON. *Mt. Wilson Observat., Contrib. No.* 631. *Astrophys. J.*, **92**, *pp.* 170–192, *Sept.*, 1940.—The observed radial velocities of O and B stars, Cepheid variables, non-Cepheid c stars and interstellar gases, all located within 30° of the galactic plane, have been analysed to determine values of the galactic rotation constant A. The values derived from objects at different distances from the sun are brought into fair agreement by assuming a mean effective absorption $a = 0{\cdot}65$ mag/kpc for both visual and photographic light. Since the distribution of the absorbing material is definitely not uniform, this assumption does not lead to a true value of A. A linear relation between the observed values of A and the photometric distances is found. This brings all the observed values into satisfactory accord and gives a mean value $A = 17{\cdot}7 \pm 0{\cdot}7$ km./sec.kpc. Applied to visual and photographic sequences for rA, this value of A gives values of the mean absorption consistent with values derived on the assumption of uniform distribution. Comparison of results based upon the planetary rotation theory and upon Milne's more general formulae indicates that the values of a and A are nearly independent of the underlying theory. AUTHOR.

2934. Mean coefficient of selective absorption in the galaxy. J. STEBBINS, C. M. HUFFER AND A. E. WHITFORD. *Mt. Wilson Observat., Contrib. No.* 632. *Astrophys. J.*, **92**, *pp.* 193–199, *Sept.*, 1940.—From the colours of B stars near the plane of the Galaxy and out to 2 000 parsecs. from the sun it is concluded that the effect of the interstellar material is too irregular to be represented by a mean coefficient of selective or of total absorption. AUTHORS.

2935. DO Aquilae 1925—An unusual nova of the Nova Pictoris 1925 type. B. VORONTSOV-VELYAMINOV. *Astrophys. J.*, **92**, *pp.* 283–288, *Sept.*, 1940.—The star in its decline showed strong lines of [Fe 11], and its light-curve appears to be a duplicate of that of Nova Pictoris. The comparison leads to the reconstruction of unobserved parts of both curves. AUTHOR.

2936. Spectrophotometric study of Nova Lacertae, 1936. D. M. POPPER. *Astrophys. J.*, **92**, *pp.* 262–282, *Sept.*, 1940.—Nova Lacertae, 1936, was observed with the quartz slitless spectrograph of the Lick Observatory between July 2 and November 21, 1936. Plates obtained on 9 nights were chosen for reduction over the spectral region $H\alpha$ to λ 3 100. The intensities of various features were referred to the intensity in 1 Å of the continuum of the star π^1 Cygni at the wavelengths of these features. The results were converted to relative intensities by applying an assumed intensity distribution in the spectrum of π^1 Cygni and by correcting for space absorption. The resulting intensities are shown. The results are discussed on the basis of the expanding envelope model of the nova. Brief comparisons are made with some results found in the literature for planetary nebulae and for other novae. AUTHOR.

2937. Classification of the A stars. Part I. The spectral types of the brighter members of the Hyades cluster. J. TITUS AND W. W. MORGAN. *Astrophys. J.*, **92,** *pp.* 256–261, *Sept.*, 1940.—The problem of the classification of the A stars is discussed. Revised spectral types of 72 of the brighter Hyades are given on a system which is in close agreement with that of the Henry Draper Catalogue. The main sequence defined by the ordinary Hyades stars appears to coincide with the main sequence determined from stars in the sun's neighbourhood over the spectral range A5–G0. Attention is called to a group of 6 A1–A5 stars which appear to be of lower luminosity than the ordinary main sequence. The most striking characteristic of these objects is the great strength of the metallic arc lines in their spectra. The latter can be described as composite. In each case, however, the spectrum probably originates in a single star. AUTHORS.

SUN.

***2938. The coronaviser, an instrument for observing the solar corona in full sunlight.** A. M. SKELLETT. *Nat. Acad. Sci., Proc.*, **26,** *pp.* 430–433, *June*, 1940.—The instrument makes use of television apparatus. As the scanning spot travels round the field near the sun's edge, the general glare gives rise to a direct current in the photocell. But prominences and other coronal features generate a current of varying amplitude which is alone amplified and reproduced. Instrumental sources of distortion are discussed. G. C. McV.

See also Abstract 2945.

GEOPHYSICS.

GEOPHYSICS, APPLIED.

2939. Interpretation of seismograms. H. J. MCCREADY. *Mines Mag.*, **30,** *pp.* 439–443, *Aug.*, 1940.—The factors involved in the interpretation of data obtained by seismic prospecting are summarized. In the quantitative interpretation calculations of velocity and dip, the character of the waves and the instrument setting, are of importance, and the results are reduced to a geological datum, usually the base of the weathered layer. The method of using wave reflections is explained and the correlation of data and methods of interpretation of the records outlined. The causes of bad records are examined. It is considered that the solution of any problem involves a background of practical experience and knowledge and a logical interpretation of theory. R. S. R.

LAND, PHYSICS OF THE.

2940. Problem of the earth's density variation. K. E. BULLEN. *Seismological Soc. of America, Bull.*, **30,** *pp.* 235–250, *July*, 1940.—The paper examines the problem of the earth's density variation and includes a quantitative discussion of the errors likely to be involved. Figures are given for the density distribution of the earth's outer mantle, and it is shown that all these are probably accurate within about $0 \cdot 05$ gm./cm^3. On the figures presented the density in the earth's mantle ranges from

$3{\cdot}32$ gm./cm^3. at the base of the crustal layers to $5{\cdot}68$ gm./cm^3. at the base of the mantle. The mean density of the central core is shown to be $10{\cdot}7$ gm./cm^3. within an error of order $0{\cdot}1$ gm./cm^3. Application of equations derived by Birch from Murnaghan's theory of finite strain indicates agreement with the density figures found, but it is to be noted that the rigidity of the lower portion of the earth's mantle appears to increase more slowly with increase of depth than would be consistent with the equations of Birch. Values which are expected to need very little future amendment are also given for the pressure and gravitational attraction within the earth's mantle. AUTHOR.

2941. Rejuvenated activity of the volcano Torisima (Izu, Japan). H. TANAKADATE. *Imp. Acad. Tokyo, Proc.*, **16,** *pp.* 231–235, *June*, 1940.—The history of the island is sketched from its first colonization in 1886; the earliest recorded eruption is the violent explosion of 1902; the volcano was then quiescent till 1939 when another eruption occurred of scoriaceous sand followed by lava of which an analysis is given showing $54{\cdot}11\%$ SiO_2 and resembling the 2-pyroxene andesite of an earlier eruption. Previously erupted olivine basalt containing $48{\cdot}70\%$ SiO_2 also occurs. C. A. S.

2942. Horizontal pendulum movements. F. N. DENISON. *Seismological Soc. of America, Bull.*, **30,** *pp.* 219–225, *July*, 1940.—Further notes on the N.–S. and E.–W. horizontal pendulums show a marked secular easterly movement to 1922 and pronounced westerly movements in 1899, 1911, 1912 and 1927–29, indicating abnormal earth movements during those periods. Both E.–W. and N.–S. annual curves suggest a secular tilting to the south-east over this portion of the continent. The maximum easterly swing has altered from July in 1914 to September in 1931 to 1938, while the westerly maximum movement shifted from November in the early years to February in 1938. The N.–S. pendulum shows a double annual fluctuation with maximum northerly extremes in February and July and southerly in May and October. The mean magnetic force shows also the double fluctuations, but these occur about the times of the solstices and equinoxes and the forces controlling terrestial magnetism may influence pendulum movements. [See Abstract 1020 (1938).] R. S. R.

METEOROLOGY.

2943. Measurements of solar ultra-violet radiation in Stockholm. F. LINDHOLM AND G. CRONHEIM. *Arkiv f. Mat. Astron. och Fysik, Stockholm*, **27***B*, 2, [5 *pp.*], 1940. *In German.*—Measurements were made from June–September, 1938, using (1) a photo-electric method (Cd-cell) and (2) a photo-chemical method based on the change of colour of leucocyanides in solution. In case (1) the results show that the intensity of solar radiation depends on the air mass and increases with solar height. A Se photo-element was used to determine the degree of colouring and thus the intensity of radiation. Measurements were restricted to the range 395–295 $m\mu$. R. S. R.

2944. Possible changes in the solar "constant." T. E. STERNE. K. F. GUTHE AND W. O. ROBERTS. *Nat. Acad. Sci., Proc.*, **26,** *pp.* 399–406, *June*, 1940.—A thorough periodogram analysis has been made of 540 10-day mean values of the solar constant published by Abbot. The analysed material gives harmonic components, statistically significant but not necessarily real, with amplitudes greater than 10^{-3} cal./cm^2. min. at 68, 41, 25, 20, $17{\cdot}4$, $15{\cdot}2$, $11{\cdot}2$ and $6{\cdot}3$ months. Two other peaks, at

10·3 and 9·7 months, may perhaps be subsidiary maxima associated with the 11·2-month component. These periods differ in detail from Abbot's and the 6 longest appear to be the Fourier components of a fundamental periodicity having a length of 10·2 years. Within the accuracy of the determinations this last period and the average sun-spot period at the time of the observations appear to be equal. The equality suggests the occurrence of some real changes in the solar constant, but pending the publication by Abbot of revised material this point should not be regarded as settled. R. S. R.

2945. Solar faculae and solar constant variations. H. Arctowski. *Nat. Acad. Sci., Proc.*, **26,** *pp.* 406–411, *June*, 1940.—The Greenwich data of areas of faculae, correlated for foreshortening, were compared with solar-constant values. It was found that the mean minimum of faculae occurred 1 day after the mean minimum of solar radiation, while for maxima the interval was 2 days. The solar atmosphere reacts against a full development of faculae maxima and minima. Solar-constant variations are thus not due to faculae, but the variations of the extent of the faculae are due to the same variations of photospheric radiation as those of the solar constant. It is also considered that changes of solar radiation are the direct cause of anomalies in the distribution of temperature and of all the complexity of the meteorological phenomena, depending on temperature anomalies. R. S. R.

2946. Agricultural meteorology: a statistical study of conservation of precipitation by summer-fallowed soil tanks at Swift Current, Saskatchewan. J. W. Hopkins. *Canad. J. of Research, C*, **18,** *pp.* 388–400, *Aug.*, 1940.—Changes in the moisture content of summer-fallowed soil in tanks 15 in. in diameter and 5 ft. deep set in pits in the centre of field plots at the Dominion Experimental Station, which have been recorded at fairly frequent intervals during the summer months since 1922, provided 2 series of data comprising observations in May and June and those in July and August. These have been analysed statistically in order to relate conservation to precipitation after making allowance for other variable factors. Five-factor regression equations fitted by the method of least squares gave multiple correlation coefficients of 0·95 and 0·96 between the computed and observed conservation in the 2 series. It is inferred from these equations that under average conditions a 1-day rain to the amount of 0·36 in. in May-June and 0·46 in. in July-August would be required just to offset the subsequent evaporation during a 10-day period. Increased penetration and retention of the heavier rainfalls is very definitely indicated, and it is calculated that, whereas on the average 66% of a 1-day rain of 1 in. in May-June would still be conserved at the end of 10 days, only 30% would be retained if the same amount was received in 5 daily showers each of 0–20 in. The intensity as well as the total amount of precipitation is thus emphasized as a factor of prime importance in its relation to soil moisture under semi-arid conditions. Author.

***2947. Instrument for the spectroscopic determination of precipitable atmospheric water vapour and its calibration.** I. F. Hand. *Monthly Weather Rev.*, **68,** *pp.* 95–98, *April*, 1940.—The new instrument was used to make observations at 0·9560 μ where water vapour has no appreciable effect and at 0·935 μ in the centre of the rho water vapour absorption band. It was calibrated at the Observatories of N. Mexico and California and the calibration curve evaluated. Mean seasonal values of the amount of precipitable water vapour in a vertical atmospheric column above Washington, D.C., are given. R. S. R.

2948. Advantages in the non-uniform hour of observation in the interpretation of published precipitation data. J. R. Miles. *Monthly Weather Rev.*, **68,** *pp.* 99–100, *April,* 1940.—Daily rainfall observations in U.S.A. have an hour of observation which is constant for any one station but varies from one station to another. It is shown by examples that by a juxtaposition of the 24-hour precipitation records of nearby stations of varying times of observation the maximum probable period of precipitation for a given storm will in many cases be considerably shorter than that which could be determined if all stations took observations at a uniform hour. R. S. R.

SEISMOLOGY.

2949. Earthquakes of 1934 and 1935 in Northwestern Illinois and adjacent parts of Iowa. F. M. Fryxell. *Seismological Soc. of America, Bull.*, **30,** *pp.* 213–218, *July,* 1940.

2950. Seismological work of the Coast and Geodetic Survey during 1938 in the region adjoining the Pacific Coast of the U.S. F. P. Ulrich. *Seismological Soc. of America, Bull.*, **30,** *pp.* 261–272, *July,* 1940.—A survey of the year's work to obtain as completely as possible both instrumental and observed data on earthquakes. Details are quoted of the questionnaire programme, seismic field investigations, teleseismic, tiltmeter, strong-motion and vibration work, seismic acoustics and instrumental developments. R. S. R.

2951. Macroseismic study of the Ohio earthquakes of March, 1937. A. J. Westland and R. R. Heinrich. *Seismological Soc. of America, Bull.*, **30,** *pp.* 251–260, *July,* 1940.—The area affected, details of damage and a chart of isoseismals, are given for the earthquakes of 2nd and 9th March. Possible causes of the earthquakes due to changes in geological structure are discussed. R. S. R.

2952. P up to 20° in N. America. H. Jeffreys. *Seismological Soc. of America, Bull.*, **30,** *pp.* 225–234, *July,* 1940.—The times of P are assumed of the form $a + b\Delta + 0\cdot001c(\Delta - 1^\circ)^3$. Values of a, b and c were calculated for 8 earthquakes in the range 1° to 19·6°. It is concluded that there is some evidence for a slightly lower velocity for P in N. America than in Europe and Japan, but the amount of difference is uncertain and the data are not sufficient to provide times of transit for N. American earthquakes comparable in accuracy with those for European and Japanese ones. R. S. R.

2953. Love waves of the South Atlantic earthquake of August 28, 1933. J. T. Wilson. *Seismological Soc. of America, Bull.*, **30,** *pp.* 273–301, *July,* 1940.—The epicentre of the S. Atlantic earthquake of August 28, 1933, was located at 58° 56′ S, 24° 54′ W, and the time of occurrence fixed as $22^h\ 19^m\ 38^s$ U.T. A study is made of the first motion of P. On the assumption that the earthquake was caused by a fault movement, the strike of the fault is determined as between N 33° W and N 1° E and the dip as between 63° E and 76° E. By integration of the seismograms the earth motion during the G phase was determined at 17 stations. This wave was found to agree with the theoretical surface wave of Love. A study of the dispersion of G yielded the following conclusions. The crustal structure of the Atlantic Ocean region is very similar to that of the Indian and Pacific regions and is characterized by having material with a high velocity for shear waves, much nearer the surface than is observed in the continental regions. The thickness of the crustal structure in continental regions is about 30 to 40 km. AUTHOR.

TERRESTRIAL ELECTRICITY AND MAGNETISM.

2954. Region formation in the ionosphere acording to an attachment theory. M. V. WILKES. *Cambridge Phil. Soc., Proc.*, **36**, *pp.* 479–484, *Oct.*, 1940.—The paper contains some ionization-height curves for an isothermal ionized atmosphere in which the mechanism of electron disappearance is attachment to oxygen atoms at a rate proportional to the product of the number of oxygen atoms and of electrons present. Chapman's formula for the rate of production of ions is used. The curves were obtained by means of a differential analyser. AUTHOR.

2955. Measurement of point discharge current during disturbed weather at Colaba. M. W. CHIPLONKAR. *Indian Acad. Sci., Proc. A*, **12**, *pp.* 50–59, *July*, 1940.—The paper describes the results of measurements of point discharge currents made at the Colaba Observatory, Bombay, in 1938. A discharging point was erected on a pole at a height of 8·3 m. above ground and connected to earth through a Moll galvanometer ; the deflections of the galvanometer were recorded photographically on as many occasions of disturbed weather as possible. A current/potential gradient curve was prepared and, on occasion when the current records were missed, the electric discharges through the point were estimated from this curve. The results show that during the year there was an outflow of 30·6 millicoulombs of positive electricity from earth to air and an inflow of 10·4 millicoulombs from air to earth, giving a net outflow of 20·2 millicoulombs and a ratio of outflow to inflow equal to 2·9. Experiments made with a bunch of 4 points at the same height showed that the discharge through the bunch of points was markedly smaller than that through a single point at the same height. AUTHOR.

2956. Estimation of the air-earth current. P. J. NOLAN. *Roy. Irish Acad., Proc. A*, **46**, *pp.* 65–75, *Aug.*, 1940.—A new aspiration null method to obtain conductivity, which involves no measurements of capacitance or voltage, is described. This was compared with Wilson's method, determining the conductivity at Glencree over the period November, 1937, to July, 1939. It was found that the conductivity at 1 m. above ground by the new method exceeded the value obtained with Wilson's method by 12%. The observation of non-ionic negative air-earth currents on a few occasions in fine weather is described and discussed. The exposure factor has been found and a mean value of $2{\cdot}7 \times 10^{-16}$ A/cm^2. for the air-earth current (Wilson method) referred to an open site deduced. Reasons are given for believing that this is not a true mean annual value. R. S. R.

2957. Magnetic disturbance during sudden fade-outs of radio transmission. H. NAGAOKA. *Imp. Acad. Tokyo, Proc.*, **16**, *pp.* 201–207, *June*, 1940.—The use of an induction magnetograph of increased sensitivity to measure the time rate of change of terrestrial magnetic force during magnetic disturbances which cause sudden fade-outs of radio transmission is described. Observed magnetograms indicating the presence of " bays " are recorded and briefly discussed. W. R. A.

See also Abstract 2942.

RADIOACTIVITY.

2958. Resonance capture of slow neutrons and emission of gamma-rays. Part II. I. Nonaka. *Phys. Math. Soc. Japan, Proc.*, **22,** *pp.* 551–560, *July*, 1940.—The method of investigating resonance neutron groups of any nucleus not made radioactive by neutron capture, by utilizing the γ-rays emitted in the capture process itself, is extended to Cl, Co, Ag and Ba. As the intensity of the γ-rays emitted from these nuclei was very small, except in the case of Ag, no such distinct results were obtained as in the case of Cd or of Hg reported previously [Abstract **414** (1940)]. But from analysis of the γ-ray intensity curves it can be shown that Cl has no distinct resonance groups, Co has a group of about $10^1 - 10^2$ eV in energy, and Ba has a group of very high energy (perhaps of the order of 10^3 eV). The result for Ag is in qualitative agreement with that obtained by the ordinary method of β-ray activity. In addition, the relative number of γ-ray quanta emitted per capture of a thermal neutron was found to be 0·64, 0·74, 1·00 and 0·82, for Cl, Ag, Cd and Hg, respectively. These results are compared with those of other investigators. Author.

2959. Photo-disintegration of deuteron by radium γ-rays. M. Miwa. *Phys. Math. Soc. Japan, Proc.*, **22,** *pp.* 560–568, *July*, 1940.—The mean free path of Ra γ + D neutrons in paraffin was determined by the scattering method and found to be $12{\cdot}7 \pm 2{\cdot}0$ mm. This value is higher than that expected for the 2·198 eMV line of RaC. It is concluded that there exists a RaC line (or lines) having effective energy of 2·6 eMV and more effective in liberating the neutron from deuteron than the 2·198 eMV line. The yield and angular distribution of photoneutrons were found to favour this conclusion. RaC γ-rays of 2·198 eMV are less effective in disintegrating the deuteron than expected for a virtual ^1S level. This is in good agreement with the observation on the angular distribution of RdTh γ + D neutrons, but is contrary to evidences obtained with thermal neutrons. Author.

***2960. Integrating circuit for vapour-type Geiger-Müller counters.** L. F. Curtiss. *Bureau of Standards, J. of Research*, **25,** *pp.* 369–377, *Sept.*, 1940.—A circuit is described for integrating the pulses from tube counters filled with alcohol vapour and argon and for measuring the output on a rugged milliammeter. A simple resistance-capacitance coupled amplifier is arranged to amplify and level the pulses. They are then rectified and fed into a condenser with resistance leak. A vacuum-tube voltmeter stage is incorporated in the circuit to measure the voltage of this condenser. This voltage is proportional to the counting rate under the conditions obtained in this circuit. Two types of portable apparatus operated from the 110 V a.c. supply are described. One is a sensitive counter unit suitable for measuring low γ-ray intensities down to the equivalent of 0·1 μgm. of radium. The output meter is a milliammeter with a full scale deflection of 1·5 mA. A multi-range switch permits operation at several sensitivities. On the most sensitive range the sensitivity is 0·03 mA/μgm. of radium at 1 m. The scale of the meter is linear with the counting rate so that comparisons between radioactive sources can be made when desired, without reference to the calibration curve. A carefully prepared calibration curve can be used to determine γ-ray intensities in this region of intensity to within a few percent. The calibration remains comparatively steady over periods of months. The other apparatus based upon the same circuit is a dosage meter for γ-rays, which indicates on a milliammeter the γ-ray dosage in terms of r. per day and in addition gives a visual and audible alarm when this dosage reaches the tolerance level of 0·1 r. per day. At the present time a general exposure of this amount is regarded as safe. This equipment is designed to give warning of excessive general exposures wherever large sources of γ-radiation are present, such as in the use of radium, h.v. tubes and cyclotrons. AUTHOR.

See also Abstract 2871.

RADIATION.

ABSORPTION.

2961. Colour in relation to chemical constitution of the phthalein dyes. S. DUTT. *Indian Acad. Sci., Proc. A*, **11**, *pp.* 483–490, *June*, 1940.—Unsymmetrical phthaleins, obtained by condensation of o-benzoyl-benzoic acid with phenols and aminophenols, develop a much less intense colour when dissolved in alkalies than do the symmetrical phthaleins obtained by condensation of the same phenols and aminophenols with phthalic anhydride. This is ascribed to the fact that the tendency towards tautomerism between lactonoid and quinonoid forms is much less in the unsymmetrical phthaleins than in the symmetrical compounds. A. J. M.

2962. Infra-red absorptions of some polyhydroxylic compounds. M. M. DAVIES. *Faraday Soc., Trans.*, **36**, *pp.* 1114–1120, *Oct.*, 1940.—The infra-red absorptions of a number of polyhydroxylic compounds are reported. In particular, the results for trichloracetic acid and its hydrate, diphenyl-triketone hydrate and saligenin, are discussed in relation to the structure of these molecules. AUTHOR.

2963. Ultra-violet absorption of cobalt salts and some light filters for the ultra-violet region. H. L. J. BÄCKSTRÖM. *Arkiv f. Kem. Min. och Geologi, Stockholm*, **13A**, 24, [16 *pp.*], 1940. *In German.*—Aqueous solutions of $CoSO_4$ and of $NiSO_4$ have a high degree of transparency for the ultra-violet if the solutes are pure. Mixtures of concentrated solutions of the two pure salts may be used as light filters, transmitting light of wavelength 220–340 mμ but absorbing all light of longer wavelength. A method for obtaining the pure salts from the commercial products is described. A. J. M.

COLORIMETRY.

***2964. Photo-electric colorimeter-fluorimeter.** D. K. FROMAN AND W. D. MCFARLANE. *Canad. J. of Research, B*, **18**, *pp.* 240–245, *Aug.*, 1940.—A photo-electric colorimeter of the compensating 2-photocell type is described. It is simple in design, relatively inexpensive to construct and satisfactory in performance. By changing the lamp and filters it can be adapted to fluorescence measurements. AUTHORS.

EMISSION.

2965. Interaction energies in radiation theory. H. HURWITZ, JR. *Phys. Rev.*, **58**, *pp.* 467–471, *Sept.* 1, 1940.—Radiation interaction energies are calculated for a photon and electron, a photon and scalar or vector mesotron, 2 electrons and 2 scalar mesotrons. For a charged particle and photon the interaction energy is inversely proportional to the frequency of the photon and does not transform like the time component of a 4-vector. For 2 charged particles the interaction energy is closely related to the Møller matrix element. AUTHOR.

2966. Time variations in cosmic-ray intensity at high altitudes. W. P. JESSE. *Phys. Rev.*, **58**, *pp.* 281–287, *Aug.* 15, 1940.—Twelve balloon flights with a recording cosmic-ray ionization chamber apparatus have been carried out at Chicago between October, 1938, and November, 1939. The results show marked changes in cosmic-ray intensity during this period, the maximum variation observed being about 14% for the peak value of the ionization pressure curve. The changes follow in general the " world-wide " variations of cosmic rays observed at ground stations, but when the high-altitude results are somewhat arbitrarily corrected for such " world-wide " variations certain residual changes remain. These residual variations show a maximum in the early spring of 1939, then a sudden drop of about 8% and lower values during the early summer with increasing values again in the autumn. Whether this represents a true seasonal effect can be determined only by further experiments. Though there is some indication that the variations are related to magnetic changes, the agreement with the theory of Vallarta and Godart is not quantitatively good. AUTHOR.

2967. Solid angle subtended by the main and shadow cones of cosmic radiation. H. P. KOENIG. *Phys. Rev.*, **58**, *pp.* 385–386, *Sept.* 1, 1940.—For the calculation of the longitude and latitude effects, as well as the time variations, of charged primary cosmic radiations, the knowledge of the solid angle subtended by the main and shadow cones for all latitudes and energies is essential. This solid angle is calculated over a wide range of energy and latitude from the results of Lemaître and Vallarta and from those of Schremp, and the results are given in the form of several graphs. AUTHOR.

2968. Fine structure in the directional intensity of cosmic rays. D. COOPER. *Phys. Rev.*, **58**, *pp.* 288–292, *Aug.* 15, 1940.—The effect relating to fine structure in the zenith-angle distribution of cosmic-ray intensity was investigated with a triple coincidence circuit of Geiger-Müller counters. Three counters, each of diameter 8·8 cm., active length 36 cm., were made according to the method of Shonka. The counters were used with a separation of 50 cm. between the centres of adjacent counters in a modified circuit of the Neher-Harper type. Readings were taken in a cyclic fashion to minimize errors due to possible instrumental sensitivity drifts, changes in the barometric pressure and changes in the magnetic field of the earth. Five-degree intervals were investigated in the zenith-angle range from 0° to 45°, inclusive, in all the directions studied. The survey of intensities in the east, west, north, south, southwest, southeast, northwest, and northeast azimuths exhibits intensity patterns with small oscillations. The prominences measured in terms of the largest positive deviations from the $\cos^2\theta$-curve are of the order of 2 or 3% of the intensity, and they occur at approximately 7°, 20° and 37°. The directional intensity pattern shows an approximate symmetry about the zenith. These results tend to confirm the predictions of Schremp relative to the existence of a fine structure due to a line or banded nature for the energy spectrum for cosmic rays at infinity. AUTHOR.

FLUORESCENCE AND PHOSPHORESCENCE. LUMINESCENCE AND AFTER-GLOW.

2969. Fluorescence of hydrocarbons and of their mixtures with naphthacene. F. Weigert. *Faraday Soc., Trans.*, **36**, *pp.* 1033–1035, *Oct.*, 1940.

2970. Fluorescence analysis. Part III. On fluorescence-adsorption indicators. H. Gotô. *Tohoku Univ., Sci. Reports*, **28**, *pp.* 513–527, *March*, 1940. —[See Abstract 1804 (1940).] Argentometric titrations of HCl solutions exposed to ultra-violet rays were studied using fluorescein, eosine, umbelliferone, β-naphthol sulphonic acid, β-naphthol, phloxine and dichlorofluorescein as "fluorescence-adsorption indicators", and the effects of ethyl alcohol, methyl alcohol, acetone and dextrine, were also investigated. Author.

2971. Fluorescence analysis. Part IV. α-Naphthoflavone as a fluorescence indicator in iodometry and bromometry. H. Gotô. *Tohoku Univ., Sci. Reports*, **19**, *pp.* 1–8, *June*, 1940.—α-Naphthoflavone was applied to iodometry and bromometry as a fluorescence indicator. Good results were obtained in iodometry with a certain correction whereas those of bromometry were very accurate necessitating no correction. Both titrations in coloured solutions were also carried out simply. Author.

See also Abstracts 2964, 2976.

INTERFERENCE, DIFFRACTION AND SCATTERING.

2972. Colours of stratified media. Part I. Ancient decomposed glass. C. V. Raman and V. S. Rajagopalan. *Indian Acad. Sci., Proc. A*, **11**, *pp.* 469–482, *June*, 1940.—Details are given of a microscopic study of the structure of films of ancient decomposed glass and of a spectroscopic examination of their iridescence. It appears that Brewster's explanation (iridescence due to air films separating thin layers of glass) is incorrect, since the medium is optically and mechanically continuous. There are, however, stratifications present and these cause reflection or transmission of particular parts of the spectrum. The effects vary with the angle of incidence and with the azimuth of the vibration. Mechanical pressure destroys the iridescence. Liquids can penetrate the film structure but the films only become optically homogenuous when the liquid refractive index is equal to that of the glass. As the wetted film dries the liquid withdraws first from the larger cavities. This results in the optical stratifications becoming more pronounced, with the result that the flakes appear black by transmission and silvery white by reflection. A. H.

REFLECTION, REFRACTION AND DISPERSION.

2973. Correction of lattice spacings for refraction. A. J. C. Wilson. *Cambridge Phil. Soc., Proc.*, **36**, *pp.* 485–489, *Oct.*, 1940.—The increase in the angle of reflection from a powdered crystal varies from $(1 - n)\tan\theta$ to $(1 - n)(\tan\theta + \cot\theta)$ as its absorption increases. In either case the true lattice spacing of a cubic crystal is obtained by increasing the extrapolated lattice spacing by a fraction $1 - n$ of itself. The divergence of the reflected beam by refraction is small in comparison with other causes of line width. Author.

See also Abstract 2972.

SPECTROSCOPY.

2974. Quantitative spectrographic analysis. Part I. Method of relative intensities with internal standard. Part II. Method of relative intensity ratios with normalized external standard. J. T. M. Malpica. *Gen. El. Rev.*, **43**, *pp.* 288–297, *July, and pp.* 333–335, *Aug.*, 1940.—In the first part is presented a method of spectrographic analysis using relative intensities with an internal standard. The calibration of the plate is performed by means of a rotating sector disc, and a mechanical method of plate development to ensure uniformity is described. The effect of changing certain variables (exposure time, electrode separation, etc.) is examined. In Part II it is pointed out that the work already described does not eliminate error due to variation in spectral response of the plate. The magnitude of this error is examined and an external standard method to eliminate the error described. A. H.

2975. Arc spectrum of Co. H. N. Russell, R. B. King and C. E. Moore. *Phys. Rev.*, **58**, *pp.* 407–436, *Sept.* 1, 1940.—The present analysis classifies 2 725 lines and identifies 768 multiplets of the doublet, quartet and sextet systems. The results are in complete agreement with Hund's theory and indicate that all the important features of the structure of the neutral atom are now known. The results agree closely with those of Catalan and Antunes (who classified 2 076 lines) except where changes in term designations have been made on account of Zeeman data or of a new interpretation of the convergence of the components of multiple terms to their limits. The principal ionization potential is 7·84 V. Tables are given of terms, of electron configurations and of 3 007 lines of which 91% are classified. Zeeman effects have been observed for 871 lines and *g* values derived for 270 levels. The large majority of these have nearly the theoretical values for *LS* coupling. There are some cases of *g* sharing. The wavelength list includes measures of 1 282 lines made with the interferometer and 274 newly measured lines between λ2 230 and λ1 814. Authors.

2976. Effect of an activator on the absorption spectrum of ZnS powders. C. J. Brasefield. *Phys. Rev.*, **58**, *pp.* 436–438, *Sept.* 1, 1940.—The absorption of ZnS powders, both pure and with various concentrations of activator, was measured in the region 3 200–4 800 Å by the diffuse-reflection method. It was found that the long-wavelength limit of the absorption band for a pure ZnS powder was at 3 800 Å and that this limit moved to longer wavelengths with increasing concentration of Ag activator. No evidence could be found of a secondary absorption peak characteristic of the activator. Author.

2977. Radio-frequency spectra of Na, Rb and Cs. S. Millman and P. Kusch. *Phys. Rev.*, **58**, *pp.* 438–445, *Sept.* 1, 1940.—The hyperfine structures of the ground state of Na^{23}, Rb^{85}, Rb^{87} and Cs^{133} were measured by observing radio-frequency spectra of these atoms. In each case the particular lines chosen for study and the magnetic fields at which they were observed were such as to yield the greatest precision for the hyperfine structure measurements, consistent with frequencies conveniently obtainable in the laboratory (up to 700 Mc./s.). The measured h.f.s. separations are given both in absolute frequency units and in wave numbers. [See Abstract 2135 (1940).] Authors.

2978. Impact broadening of spectral lines. L. Spitzer, Jr. *Phys. Rev.*, **58**, *pp.* 348–357, *Aug.* 15, 1940.—An evaluation is made of the error introduced into current impact-broadening theory by the 2 incorrect assumptions usually made—the adiabatic approximation and the neglect of the rotation of the adiabatic electron states in the computation of the interaction between these states and the radiation field. A simple case of resonance-broadening is examined with the aid of wave functions in a non-rotating co-ordinate system, and the emitted intensity is shown to be reduced by a factor of 2 in the first approximation from the value given by the usual impact formula. This discrepancy is no greater than other errors in the present theory of line broadening and will be less for dispersion, van der Waals and other second-order forces since these forces do not vanish on the average and will show little tendency to do so in a single encounter. The Weisskopf formula, despite its theoretical imperfections, may therefore be used to give approximate results for impact-broadening. A criterion is also given for the transition between impact and statistical broadening; for resonance forces under normal conditions the impact-broadening formulae are shown to be irrelevant, since they apply only within a distance of 10^{-1} Å from the line centre, and outside this range the statistical formulae must be applied. Although this is substantially the range of Doppler broadening, accurate measurements of line centres at low pressures should provide a qualitative test of the present theory in the case of resonance-broadening. The influence of the previously neglected "rotation effect" on the interaction between a H-atom perturbed by a passing ion and the radiation field is calculated with relative exactness for the first excited state. AUTHOR.

2979. Spectrum of the P_2 molecule. G. HERZBERG, L. HERZBERG AND G. G. MILNE. *Canad. J. of Research, A*, **18**, *pp.* 139–143, *Aug.*, 1940.—Five bands of the ultra-violet system of P_2, with low v' and v'' values, have been measured under large dispersion and analysed. They serve to determine much more accurately than heretofore possible the rotational constants B_e'' and α_e'', the moment of inertia I_e'', and the internuclear distance r_e'' of the P_2 molecule in the ground state. The following values have been found: $B_e'' = 0{\cdot}3031$ cm^{-1}., $\alpha_e'' = 0{\cdot}00138$ cm^{-1}., $I_e'' = 92{\cdot}36 \times 10^{-40}$ gm.cm^2., $r_e'' = 1{\cdot}895{\cdot}10^{-8}$ cm. AUTHORS.

2980. Pre-dissociation phenomena in hydride spectra with the hollow cathode. E. HULTHÉN. *Arkiv f. Mat. Astron. och Fysik, Stockholm*, **27B**, 5, [3 *pp.*], 1940. *In German.*—The anomalous intensity relationships in the band spectra of CuH, AlH and BiH, observed by Schüler and others and ascribed by them to a deposition-evaporation process occurring at the walls of the cathode, can be brought into relationship with the phenomena of pre-dissociation. This effect is likely to be of considerable importance at the low pressures in the hollow-cathode method. A. J. M.

2981. Near ultra-violet absorption spectrum of heavy benzene. H. SPONER. *J. Chem. Phys.*, **8**, *pp.* 705–710, *Sept.*, 1940.—The absorption spectrum of heavy benzene at 2700–2300 Å has been analysed. As in light benzene it represents a forbidden transition $^1A_{1g} \rightarrow B^1_{2u}$ made allowed through the interaction of vibrations of type ϵ_g^+. Interpretations have been given for the majority of the bands. The measured bands together with the assignments are exhibited. AUTHOR.

2982. The estimation of ground state dissociation energies of di-atoms of symmetrical molecular groups. C. H. D. CLARK. *Leeds Philosoph. and Lit. Soc., Proc.*, **3**, *pp.* 597–601, *July*, 1940.—Two relations previously applied [Abstract 5356 (1937)] to fundamental vibration frequencies of di-atoms of symmetrical groups have been considered with a view to their applicability or modification in the case of dissociation energies D. (1) $\log D = p - n\log 2Z$, where p, n are group constants of di-atoms XX, and Z is the atomic number of X, gives satisfactory reproduction of the experimental results. The relation is used in the estimation of undetermined dissociation energies, which, together with experimental numbers, are shown graphically as periodic group functions. (2) $a^n = kbc^{n-1}$, where a, b, c are ground dissociation energies of XY, XX, YY, with $c > b$, appears to reproduce experimental results in group 14 better than formulae based on the rule of means. The values $k = 1$, $n = 5$ meet the available data satisfactorily. It appears that, as in the case of fundamental vibrations, formulae of this type overcome the errors introduced by the rule of means, which appear to be due to the influence of polar opposition of the atoms X and Y. The results obtained by these 2 relations, compared with those previously obtained by an independent empirical equation, reveal a generally satisfactory measure of agreement. AUTHOR.

2983. Investigation of hydrogen bonds by means of infra-red absorption spectra. G. B. B. M. SUTHERLAND. *Faraday Soc., Trans.*, **36**, *pp.* 889–897, *Sept.*, 1940.—A survey article which summarizes the main results of infra-red investigations on XH bonds where X represents a C, N, O or F atom. A. H.

2984. Infra-red spectra of polyatomic molecules. Part II. D. M. DENNISON. *Rev. Modern Physics*, **12**, *pp.* 175–214, *July*, 1940.—Part I [Abstract 3062 (1931)] contained a description of the theoretical methods by which the infra-red spectrum of a molecule might be interpreted, thus leading to a determination of the molecular constants. Part II was meant to deal with the applications of the methods to particular spectra but had to be held up since there was not, at that time, a single polyatomic spectrum which could be interpreted with any pretence of completeness. By now there are at least 20 such spectra which have been adequately explained and 5 of these (the spectra of CO_2, H_2O, NH_3, the methyl halides, CH_4) are discussed at length as typical examples. Advances in theory in the intervening 10 years are also considered. A. H.

2985. Analysis of the Raman and infra-red spectra of α-quartz. B. D. SAKSENA. *Indian Acad. Sci., Proc.*, **12A**, *pp.* 93–139, *July*, 1940.—On the basis of the known crystal structure of quartz the symmetry modes of vibration of the atoms in the unit cell are derived and geometrically represented and their appearance in the Raman effect and in infra-red absorption discussed. Details are also given of an experimental study of the Raman spectrum of quartz, using unpolarized incident light and also light polarized in different azimuths and with different orientations of the crystal. The experimental results obtained, as well as those already known regarding the infra-red reflection and absorption, have been satisfactorily correlated with the deductions from theory. The thermal behaviour of the Raman lines is correlated with the modes of vibration concerned. The specific heat of quartz between 23°K. and 808°K. is calculated theoretically on the basis of the analysis and is in excellent agreement with the experimental results. A. H.

2986. Fundamental frequencies of certain trihalomethanes. G. GLOCKLER AND G. R. LEADER. *J. Chem. Phys.*, **8**, *pp.* 699–705, *Sept.*, 1940.—The Raman spectra of dibromochloro-, bromo-dichloro-, dichlorofluoro-, chlorodifluoro, dibromofluoro and bromochlorofluoro-methane have been studied. Their fundamental frequencies have been correlated and systematized. Simple graphical means were used to predict the Raman frequencies of $CHBrF_2$ and CHF_3. It was found that the C − X bond will show a "characteristic" frequency whenever the halogen X is the only and lightest of this type in a halomethane. AUTHORS.

See also Abstract 2873.

X-RAYS.

2987. Diffraction of X-rays by liquid argon. A. EISENSTEIN AND N. S. GINGRICH. *Phys. Rev.*, **58,** *pp.* 307–309, *Aug.* 15, 1940.—The X-ray diffraction pattern of liquid A has been obtained with crystal-reflected Mo $K\alpha$ radiation. Argon gas under a gauge pressure of 50 lb./in². was cooled to 90°K. in a thin-walled pyrex glass capillary of 1·7 mm. diameter and under these conditions the A became liquid. An evacuated camera of 9·53 cm. radius was so constructed that the film could be placed outside the vacuum, with entrance and exit windows of Al. Exposures of 140 hrs. were required to give patterns of satisfactory density. Microphotometer records of the films showed 3 peaks; a very strong peak at $\sin\theta/\lambda = 0{\cdot}154$, a medium peak at $\sin\theta/\lambda = 0{\cdot}280$ and a weak peak at $\sin\theta/\lambda = 0{\cdot}415$. No convincing evidence of another peak could be found beyond this and up to $\sin\theta/\lambda = 1{\cdot}20$. A Fourier analysis of the diffraction pattern results in an atomic distribution curve $[4\pi r^2\rho(r)/r]$ showing approximately 7 atoms at 3·90 Å and 5 atoms at about 5·05 Å. A third broad peak occurs at over 7 Å. This indicates that the distribution of atoms in liquid A does not follow closely that in crystalline A, since in the crystal there are 12 nearest neighbours. AUTHORS.

2988. Quantum theory of X-ray reflection and scattering. Part I. Geometric relations. C. V. RAMAN AND N. S. N. NATH. *Indian Acad. Sci., Proc. A*, **12,** *pp.* 83–92, *July*, 1940.—When X-rays fall upon a crystal the characteristic vibrations of the crystal lattice may be excited thereby in much the same way as in the phenomenon of the scattering of light in crystals with diminished frequency, the excitation being a quantum-mechanical effect. From the equations for the conservation of energy and momentum the geometrical relations entering in this effect are deduced theoretically for the 2 cases in which the lattice vibrations fall within (1) the acoustic range of frequency and (2) the optical range. In the first case the incident X-rays are scattered in directions falling within a cone having the incident ray as axis and with a semi-vertical angle $2\sin^{-1}\lambda/2\lambda^*$ where λ^* is the minimum acoustical wavelength. In the second case we have a quantum-mechanical reflection of the X-rays with diminished frequency in a direction which generally follows the geometric formula $2d\sin\frac{1}{2}(\theta+\phi) = n\lambda$ where θ and ϕ are the glancing angles of incidence and reflection on the crystal spacings. For crystals with specially rigid bindings the alternative formula $d\sin(\theta+\phi) = n\lambda\cos\phi$ is indicated as being more appropriate. In either case the intensity of the reflection should fall off rapidly as θ and ϕ diverge. AUTHORS.

2989. Cu and Ni X-ray $K\beta_2$- and $K\beta_5$-emission lines and K-absorption limits in Cu-Ni alloys. H. FRIEDMAN AND W. W. BEEMAN. *Phys. Rev.*, **58,** *pp.* 400–406, *Sept.* 1, 1940.—The shapes of the Cu $K\beta_{2,5}$ lines and Ni $K\beta_5$ lines from Cu-Ni alloys vary smoothly with composition. The trend with increasing percentage of the emitting atoms is always toward a flattening out of the peaks of the lines. To explain the observed shapes it has been proposed that the major effect of alloying is a loss of 3*d* band dipole radiation with increasing dilution of the emitting atom. The absorption limits, in contrast to the emission lines, show no influence of alloying. The Cu K limit continues to look like that of pure Cu even when the emitting atom is almost completely surrounded by Ni nearest neighbours, and similarly, no changes are observed in the Ni edges even down to 21% Ni. AUTHORS.

2990. K-absorption edges and $K\beta_{2,5}$-emission lines of 2 Zn-Ni alloys. J. A. BEARDEN AND W. W. BEEMAN. *Phys. Rev.*, **58,** *pp.* 396–399, *Sept.* 1, 1940.—A double-crystal spectrometer has been used to measure the shapes of the $K\beta_{2,5}$-emission lines and the K-absorption edges of Zn and Ni in 2 Zn-Ni alloys containing 17% Zn and 30% Zn by weight, respectively. These lines arise from transitions of valence and 3*d* electrons into the empty K shell. In the 2 alloys the Zn emission line and absorption edge are shifted about 1 V toward lower energies and the line is narrowed. Ni is changed only slightly. The results indicate that the higher-energy valence electrons of Zn are shared with Ni and probably go into 3*d* states about the Ni atoms. AUTHORS.

2991. X-ray $K\beta_{2,5}$-emission lines and K-absorption limits of Cu-Zn alloys. J. A. BEARDEN AND H. FRIEDMAN. *Phys. Rev.*, **58,** *pp.* 387–395, *Sept.* 1, 1940.—The shapes of the $K\beta_{2,5}$ lines of Cu and of Zn and their K-absorption edges in the pure metals and in a series of brasses have been studied with a double-crystal spectrometer. Mixing Cu with Zn increases the high-energy part of the emission of Cu $K\beta_{2,5}$ and decreases the corresponding part of the intensity of Zn $K\beta_2$. The magnitude of this redistribution of high-energy conduction electrons between Cu and Zn is found to agree with theoretical calculations which predict a maximum positive charge of about 10% of an electronic charge on a Zn atom dissolved in a Cu lattice. The present results are offered as further support for that interpretation of Cu $K\beta_{2,5}$ structure which attributes the extra l.f. emission to 3*d* band emission. In every alloy Zn $K\beta_5$ appears with very little change in width or in intensity per Zn atom and can be definitely assigned to 3*d* quadrupole emission. No shifts of the high-energy sides of the emission lines or the corresponding absorption limits greater than the experimental error have been observed with alloying, and there appears to be no evidence of any effect of crystal structure on the emission lines. AUTHORS.

2992. Soft X-ray spectroscopy of solids. Part I. *K*- and *L*-emission spectra from elements of the first two groups. H. W. B. SKINNER. *Roy. Soc., Phil. Trans. A*, **239,** *pp.* 95–134, *Sept.* 9, 1940.—An account is given of new experimental investigations on the radiation emitted from solid elements of the first 2 groups in the periodic table in the wavelength region 40–500 Å. As a result, the properties of these soft X-ray bands have been systematized. The effect of variation of the temperature of the material is also described. The bands reflect the properties of the energy levels of the substance dealt with. A characteristic difference between those of metals and non-metals has been established. The temperature effect on the metal bands is shown to be directly connected with the Maxwellian distribution of the conduction electrons, and the influence of thermal expansion is appreciable. A new feature of the levels of a solid, namely a large broadening of the valence levels of lowest energy, is proposed. With the help of this conception the general interpretation of the bands is almost complete; they can be used for providing detailed information on the level system of specific cases. In determining the precise features of a band the crystal structure of the material is the most important factor. AUTHOR.

2993. Soft X-ray spectroscopy of solids. Part II. Emission spectra from simple chemical compounds. H. M. O'Bryan and H. W. B. Skinner. *Roy. Soc., Proc. A*, **176**, *pp.* 229–262, *Oct.* 9, 1940.—*K*- and *L*-emission bands, emitted in the soft X-ray region of the spectrum by atoms in a number of chemical compounds, have been investigated. The substances for which such spectra are available through the present or previous work are: fluorides, chlorides, bromides, iodides; oxides, sulphides; boron nitride and other boron compounds; and carbides. In the cases of SiC, BN and a number of oxides, spectra from both the component atoms forming the compound have been obtained. The results are interpreted, as those for metals and element-insulators [see preceding Abstract] to give the characteristics of the bands of levels which exist for the valence electrons in the normal state of the substance. In the case of the halides data on the *p*- and *s*-levels of the negative ions are given and it is shown that, even in this case, the crystal structure leaves its mark on the form of the bands of levels. The 2*p*-bands of oxygen from most oxides are more spread out on an energy scale, thus showing that the interaction between electrons in neighbouring atoms is considerable. The spectra of the metal ions in oxides are very complex, and an attempt is made to disentangle the factors which lead to this complication. Authors.

2994. Differential radiography. Part II. W. Watson. *Radiography*, **6**, *pp.* 161–172, *Sept.*, 1940.—In connection with the design of apparatus for producing the accumulative effect in differential radiography [Abstract 2468 (1940)] the requirements are: (*a*) a continuous motion of the focus in any direction; (*b*) a movement of the film constantly proportional and in opposite phase to that of the focus; (*c*) constant parallelism between film and objective plane; (*d*) 2 or more parallel axes in alinement with the focus; (*e*) a means of defining the relative situation of the objective plane. A number of practical methods of achieving these objects are illustrated and discussed. A. W.

HEAT.

CALORIMETRY.

2995. Specific heat of liquid methyl chloride. J. H. Awbery and E. Griffiths. *Phys. Soc., Proc.*, **52**, *pp.* 770–776, *Nov.*, 1940.—The specific heat of liquid methyl chloride has been determined over the range − 30° to + 30°C. The liquid was in a sealed container provided with a heating coil in a re-entrant tube. Stirring was effected by means of an external solenoid operating on an iron armature. The calorimeter was surrounded by an adiabatic enclosure. The quantity determined experimentally included the latent heat of the liquid vaporized and the heat supplied to warm the vapour in the calorimeter. This was reduced to give the specific heat of the liquid following saturation. Comparison of data with those of previous investigators indicates good agreement with those of Eucken and Hauck at − 30°C. and the extension of the line representing their results over the range from − 80° to − 30°C. The results given by Shorthose are slightly higher. Authors.

2996. Anomalous specific heats of seignette-electrical substances at the Curie points. W. BANTLE AND P. SCHERRER. *Helv. Phys. Acta*, **13**, **3**, *pp*. 215–216, 1940. *In German.*—Measurements of the specific heats of KH_2PO_4 and the isomorphous KH_2AsO_4 are described, from which it appears that the anomalous specific heats at the upper Curie points are strongly dependent on the mode of preparation of the crystal powders. It is possible that the small crystallites possess different internal strains from mode of disintegration and so have not their Curie points at the same temperature, or perhaps they are chemically somewhat inhomogeneous. The anomaly for Rochelle salt itself is still unexplained. H. H. HO.

TEMPERATURE.

***2997. Temperature measurement with blocking-layer photocells.** B. M. LARSEN AND W. E. SHENK. *J. of Applied Physics*, **11**, *pp*. 555–560, *Aug.*, 1940.—It is shown that if a blocking-layer photocell is simply shunted with a rather low external resistance either the current or the voltage drop across this resistance will vary nearly linearly with the intensity of illumination. The use of such an instrument for the measurement of temperature (T) gives a potential drop $\propto T^{12.34}$. The temperature scale is thus one which expands rapidly at high temperatures. The instrument can easily be made to give a continuous record and is sufficiently responsive to measure accurately temperature changes of only a few sec. duration. Full details are given of the design of such instruments and of the precautions which should be observed in their use. R. W. P.

THERMOCHEMISTRY.

2998. Explosive reactions of gases. Part I. Thermal explosion of oxyhydrogen gas at low pressures. S. HORIBA AND R. GOTÔ. *Imp. Acad. Tokyo, Proc.*, **16**, *pp*. 218–222, *June*, 1940.—Experimental evidence is given indicating that the main part of the thermal explosive reaction of a gas is not a homogeneous process throughout the gaseous phase but consists of the propagation of flame caused by a momentary exothermic catalytic reaction at the wall of the vessel. J. S. G. T.

2999. Rôle of heat conduction in thermal gaseous explosions. O. K. RICE. *J. Chem. Phys.*, **8**, *pp*. 727–733, *Sept.*, 1940.—The theory recently developed by Frank-Kamenetzky for thermal explosions in which heat is removed by conduction only has been applied to the azomethane, ethyl azide and methyl nitrate explosions. A discussion is given of the experimental results and their relation to the theory. In the case of azomethane and ethyl azide the conclusion is reached that at low pressures thermal conduction as contrasted to convection is an important, if not the exclusive, method of removal of heat from the reacting gas, with deviation appearing at high pressures. The results appear to indicate that the methyl nitrate explosion is not a thermal explosion. AUTHOR.

THERMODYNAMICS.

3000. Theory of solid helium. T. NAGAMIYA. *Phys. Math. Soc. Japan, Proc.*, **22**, *pp*. 492–503, *June*, 1940.—The energy/volume curve of solid He at absolute zero is calculated, assuming the structure to be face-centred cubic and that Lennard Jones and Devonshire's model for ordinary liquids [Abstract 2949 (1939)] is applicable, replacing the thermal by quantum-mechanical zero-point motion. The result agrees with

experiment using Margenau's interatomic potential [Abstract 203 (1940)]. Pressures and compressibilities are also calculated, but agreement with experiment is only as far as the orders of the quantities concerned.
C. A. S.

3001. The liquid state. J. E. LENNARD-JONES. *Phys. Soc., Proc.*, **52**, *pp.* 729–747, *Nov.*, 1940.—One of the main difficulties in constructing a theory of liquid structure is the calculation of the entropy, due to the many possible geometrical configurations which the atoms can take up. Recent attempts to solve this problem have been directed to finding simple models capable of reproducing the main features of the liquid state. Some progress has been made by using the concepts of order and disorder, first introduced to explain certain properties of alloys. In this connection theories of melting are of importance and these are discussed with an indication of their successes and limitations. Another problem of theoretical and practical importance is the determination of the average distribution of atoms in a liquid. Information of this kind can be derived from the study of X-ray diffraction patterns of liquids. Recently, attempts have been made with notable success to calculate distribution functions theoretically from known atomic forces. These have been compared where possible with those derived from experiment and information has been derived about the number of nearest neighbours and the sizes of the various co-ordination shells. The significance of observations on viscosity and specific heats of liquids is examined, and reference is made to recent theories of the condensation of gases. AUTHOR.

3002. Thermodynamic properties of propane. J. H. BURGOYNE. *Roy. Soc., Proc. A*, **176**, *pp.* 280–294, *Oct.* 9, 1940.—Existing physical and thermal data relative to propane have been summarized and correlated, and some new experimental determinations of *p-v-T* relationships for the liquid at low temperatures have been carried out to make up for deficiencies in the literature. On the basis of the information thus obtained the entropy and enthalpy of propane have been calculated for conditions of temperature between — 80° and 200°C., and at pressures of from 0·1 to 200 atm. The results are tabulated and also presented graphically on a temperature base. AUTHOR.

See also Abstract 2879.

VAPORIZATION AND CONDENSATION.

3003. Periodic phenomena in the evaporation of solutions. G. F. SMITH. *Leeds Philosoph. and Lit. Soc., Proc.*, **3**, *pp.* 603–607, *July*, 1940.—In the rapid evaporation of certain very dilute solutions the solute is deposited on the side of the containing tube in the form of very fine rings parallel to the liquid surface. The distance between the rings is found to increase with the rate of evaporation. During the evaporation a ring of deposit is formed along the line of contact between the upper edge of the meniscus and the surface of the tube. This deposit anchors the meniscus, and when the latter finally breaks away it falls an appreciable distance to a new position, where a second ring forms. A possible explanation of the phenomenon is given in terms of surface forces. AUTHOR.

ACOUSTICS.

3004. Sound-prevention mechanism of non-porous materials. Part I. S. Kawashima. *Acoustical Soc. of America, J.*, **12**, *pp*. 75–82, *July*, 1940.—A theoretical consideration of the problem leads to the conclusion that the transmission loss of plate-like materials is determined by geometrical shape and boundary conditions as well as by inherent physical properties. Tests were made on a circular glass plate and on 5 square gypsum plates of various thickness. The results, given in graphs, show that the transmission loss is a minimum at the natural frequency of the plate and increases gradually with the exciting frequency. In the case of elastically restrained non-porous thin materials the principal part of sound transmission mechanism is due to diaphragm action, and in the expression of the transmission loss of building materials not only the weight per unit area of the material but also the boundary conditions play a very important part. G. E. A.

3005. Problems in the analysis of the tone of an open organ pipe. P. A. Northrop. *Acoustical Soc. of America, J.*, **12**, *pp*. 90–94, *July*, 1940.—Measurements of the intensities of the first 5 partials of a *C* 512 pipe were made in a well padded room by microphone, amplifier and analyser. Pressures along lines parallel to the pipe were determined by experiment and by calculation, and the results indicate that there is no single point at which an analysis can be made which will be representative of the practical performance of an open organ pipe. Measurements close to the mouth and end of the pipe are of limited predictive value. G. E. A.

3006. Effect of wall materials on the steady-state acoustic spectrum of flue pipes. C. P. Boner and R. B. Newman. *Acoustical Soc. of America, J.*, **12**, *pp*. 83–89, *July*, 1940.—A history of the opinions held by various authorities on the subject is summarized. The structure and material at the mouth of the pipe was kept unaltered and cylinders of different materials, including steel, copper, wood and paper, were fitted. Analyses of the spectra given by the pipes were made by a method previously described [Abstract 3329 (1938)], and the authors' conclusion is that, with the exception of the paper cylinder, the material of a flue pipe above the upper lip has very little effect on the steady-state spectrum of the pipe. The amplitude deficiencies of the paper pipe are not particularly great. G. E. A.

3007. Practical aspects of architectural acoustics. V. O. Knudsen. *Acoustical Soc. of America, J.*, **11**, *pp*. 383–389, *April*, 1940.—The principles of geometrical acoustics, though helpful in acoustical design, may lead to serious errors, especially with small rooms, and problems require also the application of the principles of physical acoustics. Good acoustical design has as its object the proper control of the distribution of sound energy throughout a room and of the growth and decay of transient sounds. Good acoustical quality can be attained in certain rooms only by distributing the absorptive material on walls as well as ceiling. Resonant peaks are most prominent in small rooms and occur particularly for low-pitched tones. The best music studios have a nearly flat reverberation characteristic with a reverberation time of 1 to 2 sec., depending on the size of the room. Typical errors are described, with the methods of eliminating them. The steps necessary to obtain good results are then given, from the choice of the site to the furnishing, testing and maintaining of the building. G. E. A.

3008. Planning functionally for good acoustics. J. P. Maxfield and C. C. Potwin. *Acoustical Soc. of America, J.*, **11**, *pp.* 390–395, *April*, 1940.—Of the physical factors which give rise to reception qualities pleasing to the listener one is a desirable amount of reverberation and its frequency characteristic for a given room; a nearly flat characteristic has yielded the best general results for both speech and music in rooms of less than 50 000 ft^3. The second deals with the nature of the successive first-order reflections reaching the listener and includes the manner in which the sound dies away during the reverberation decay period. The third deals with certain techniques which control the frequency characteristic of the first reflections reaching the listening area and their relationship to (*a*) the sound coming directly from the source and (*b*) the general background of reverberation. In lecture rooms the enclosed volume exclusive of the stage may be kept as low as 130 ft^3. per seat. For musical productions a greater volume appears desirable. As an illustration the paper gives a description of the theatre recently completed at the University of Wisconsin. G. E. A.

3009. Characteristics and distribution of impaired hearing in the population of the U.S. W. C. Beasley. *Acoustical Soc. of America, J.*, **12**, *pp.* 114–121, *July*, 1940.—During 1935 and 1936 the U.S. Public Health Service conducted an investigation which included information on the condition of hearing of the members of a household. The types of impairment were classed in 5 groups. The population on which the report is based was entirely urban and quotas were taken in 83 cities. G. E. A.

3010. Correlation between hearing-loss measurements by air conduction on 8 tones. W. C. Beasley. *Acoustical Soc. of America, J.*, **12**, *pp.* 104–113, *July*, 1940.—A report based on an analysis of 56 correlation tables derived from measurements of auditory acuity by air conduction on 16 620 ears. The ages of the subjects ranged from 8 to 90 years. The method of making up the tables for each possible combination of the tones 64 to 8 192 c./s. is stated, and the curves which result are called regression curves. G. E. A.

3011. Measurements of the noise from aerofoils and streamline wires. W. F. Hilton. *Phil. Mag.*, **30**, *pp.* 237–246, *Sept.*, 1940.—Noises measured in a high-speed wind tunnel were of 3 kinds. The first consisted of rushing sounds similar to those produced by the empty tunnel. These can be considerably reduced by ordinary acoustic absorbents. Noises of the second class are whistling sounds of high definite pitch, occurring at any speed below the shock-stall and causing the greatest annoyance. They may be entirely eliminated by roughening the surface producing them. The third kind of noise occurs on sections having a thickness greater than 15% of the chord, at about shock-stalling speed. The noise is very loud (110 to 120 db), relatively low-pitched, and only partially silenced by roughening the surface. Other observations are recorded. G. E. A.

3012. Precision measurement of acoustic impedance. L. L. Beranek. *Acoustical Soc. of America, J.*, **12**, *pp.* 3–13, *July*, 1940.—The method employs a cylindrical tube with source and absorbing material at opposite ends. The method is designed to fulfil the requirements of a standardizing laboratory, to require no comparison with a standard and to be capable of measuring impedance over a wide frequency range. The theory of the method is developed, and experimental results show an accuracy of from 3 to 5%. G. E. A.

3013. Acoustic impedance of commercial materials and the performance of rectangular rooms with 1 treated surface. L. L. BERANEK. *Acoustical Soc. of America, J.*, **12,** *pp.* 14–23, *July*, 1940.—The specific normal impedance was measured for 15 materials with rigid wall backing by means of the cylindrical tube method. The existence of an important imaginary component of impedance at all frequencies was found for almost all the materials. The magnitude and sign of the reactance term play an important part in the determination of the grazing incidence decay constant in a room, and the grazing incidence group of modes may be the most important one contributing to the support of sound. Changes in mounting conditions of materials alter the values of the impedance as determined by a small tube. G. E. A.

ELECTRICITY AND MAGNETISM.

CONDUCTION AND DISCHARGE IN GASES.

3014. Variation of sparking potential with initial photo-electric current. J. M. MEEK. *Phys. Soc., Proc.*, **52,** *pp.* 822–828, *Nov.*, 1940.—A further discussion is given of the breakdown of a discharge gap when subjected to intense ultra-violet radiation. The complete criterion for streamer formation as evolved for the writer's theory of spark discharge is adopted. This leads to a more rigorous solution of the problem than that presented in Part I, and it is shown that breakdown is probably initiated by midgap streamers for the larger photo-electric currents. AUTHOR.

3015. Occurrence of negative ions in the glow discharge through oxygen and other gases. R. W. LUNT AND A. H. GREGG. *Faraday Soc., Trans.*, **36,** *pp.* 1062–1072, *Oct.*, 1940.—In glow discharges through oxygen at pressures of about 0·5 mm. negative atomic ions have been detected in the positive column for values of Xp^{-1} about 80, their stationary concentration being comparable with that of the electrons. Under these conditions no negative ions have been detected in the negative glow or Faraday dark space, and the results show that their stationary concentration cannot have exceeded about 1% of that of the electrons. AUTHORS.

3016. Distribution of autelectronic emission from single crystal metal points. Part I. Tungsten, molybdenum, nickel in the clean state. M. BENJAMIN AND R. O. JENKINS. *Roy. Soc., Proc. A*, **176,** *pp*, 262–279, *Oct.* 9, 1940.—E. Müller has shown that the angular distribution of field emission from fine metal points can be related to the crystal structure of the metal. He also suggested that the modifications in the pattern from tungsten, which took place when the point temperature was raised, could be attributed to a movement of the surface atoms, which caused local changes in the work function. Further experiments are described in this paper, using W, Mo and Ni. It is shown that this surface mobility occurs above 1170°K. for W, 770°K. for Mo, and 370°K. for Ni. The changes in emission distribution, which are very much more marked for Mo and Ni than for W, can be completely explained in terms of a change in the geometrical shape of the point. This is brought about by the action of the high external field upon the mobile surface atoms. The flash-over phenomenon in high vacuum is discussed and an explanation offered in terms of these observations. The effect of small traces of gas is illustrated, and it is shown that the gas film is removed at the relatively low temperature of 620–670°K. Several possible suggestions are put forward to explain the dependence of the emission distribution on the crystal structure of the metal, but no definite conclusion can be reached with the data at present available. AUTHORS.

3017. Characteristics and function of anode spots in glow discharges. S. M. RUBENS AND J. E. HENDERSON. *Phys. Rev.*, **58**, *pp.* 446–457, *Sept.* 1, 1940.—Brilliant hemispherical anode spots appeared on a small disc or spherical anode mounted at the centre of a large discharge chamber which served as cathode during an investigation of nitrogen glows. Such an arrangement permits large anode current densities with a normal cathode fall in potential. At a critical current density at the anode the spots form and arrange themselves in beautiful geometrical patterns. In nitrogen the spots appeared only in the pressure range of 0·15 to 1·50 mm. Hg. Space potentials, electron temperatures, electron and ion densities determined by a Langmuir probe analysis, revealed that the spots are regions of intense ionization and that the region just above them contains a net positive space charge. The potential fall through a spot is nearly equal to the first ionization potential of nitrogen. A method was developed for growing anode spots at will on a small disc probe mounted flush with the anode surface but insulated from it. The current/voltage characteristics for this probe, or auxiliary anode, exhibit peaks which account for the stability and size of the spots. An investigation of the current/voltage relationships of the entire discharge showed that anode spots occur chiefly in the region in which the current increases with small change in voltage. At sufficiently great current densities the spots move about because of the magnetic field accompanying the discharge. The function of the spots is to furnish the positive ions necessary for the maintenance of a stable discharge in the plasma extending from anode to negative glow and to aid in the collection of electrons at the anode. A mechanism for the formation of the spots as a combined space charge and bipolar current phenomenon is proposed. AUTHORS.

3018. Chemical reaction in electric discharges. Part III. The meaning of Φ, the electrochemical analogue of the photochemical quantum yield, and the factors controlling Φ in the stationary state. R. W. LUNT AND G. E. SWINDELL. *Faraday Soc., Trans.*, **36**, *pp.* 1072–1087, *Oct.*, 1940.—The individual factors comprising the quantity Φ, the electrochemical analogue of the photochemical quantum yield, are specified. This quantity denotes the number of molecules of an observed product which are formed per electron-reactant collision generating the active species which initiates reaction and is used to relate the rate of such electron-reactant collisions to the rate of formation of the observed product.. Of these factors the only one that usually depends on the experimental conditions is the fractional utilization of the active species. From a consideration of discharge reaction proceeding in a steady state formal expressions are derived for the dependence of the fractional concentration of the active species on the experimental conditions and the rate of the relevant electron-reactant collisions. The corresponding dependence of the fractional utilization of the active species, and hence that of Φ, is then readily deducible. The extension of this analysis to the conditions in uniform positive column and negative glow reaction, and to other species, is briefly outlined. [See Abstract 1774 (1937).] AUTHORS.

3019. Chemical reaction in electric discharges. Part IV. The negative glow reaction in hydrogen-oxygen mixtures. R. W. LUNT, T. G. PEARSON AND B. TOPLEY. *Faraday Soc., Trans.*, **36**, *pp.* 1087–1111, *Oct.*, 1940.—The quantitative data for the oxidation of hydrogen in the negative glow reaction in hydrogen-oxygen mixtures have been collected, recalculated to facilitate comparisons, co-ordinated, and critically reviewed. It is shown that the main features of the reaction find a detailed explanation in terms of the general theory of Part I and of particular reaction mechanisms involving O and H atoms as the active species, based mainly on the kinetics of the non-sensitized and mercury-sensitized photo-reactions in hydrogen-oxygen mixtures. AUTHORS.

CONDUCTION IN SOLIDS AND LIQUIDS.

3020. Elasto-resistance change of Ni, Fe and some Ni-Fe alloys. N. YAMANAKA. *Tohoku Univ., Sci. Reports*, **19**, *pp.* 36–68, *June*, 1940. *Report No.* 470 *of the Research Inst. for Iron, Steel and other Metals.*—The change of electric resistance caused by tension was observed in Ni, Fe and 9 Ni-Fe alloys. In all these materials the resistance change of the magnetic origin increases or decreases with the tension, according as the magnetic elongation is positive or negative. The maximum value of that change, attained by the tension extending to the elastic limit, is in close connection with the saturation value of the magneto-resistance in each of the materials. Particularly, the resistance change caused by the comparatively weak tension conforms with the formula deduced from the domain theory of ferromagnetism so long as the maximum susceptibility is used instead of the initial one in that formula. The internal stress generated by plastic elongation seems to have an increasing effect upon electric resistance of the magnetic origin. Some interpretations of these results are put forward. AUTHOR.

3021. Longitudinal magneto-resistance effect of single crystals of Fe. Y. SHIRAKAWA. *Tohoku Univ., Sci. Reports*, **19**, *pp.* 132–151, *June*, 1940. *Report No.* 474 *of the Research Inst. for Iron, Steel and other Metals.*—The change in electric resistance of 24 single crystals of Fe at room temperature was measured up to 1 400 oersteds in a longitudinal magnetic field and the intensity of magnetization of these specimens was measured under the same condition. Specimens used were cylindrical rods, 1·7–2·6 mm. in diameter and 8·2–18·4 cm. in length. The change in resistance of a single crystal of iron is highly anisotropic, i.e. the saturation values of the change in the direction of tetragonal, digonal and trigonal axes at room temperature are 0·005, 0·36 and 0·48%, respectively. The change in magneto-resistance is very small in the range of fields in which the increase of magnetization is very large. AUTHOR.

3022. Longitudinal magneto-resistance effect at low temperatures of single crystals of Fe. Y. SHIRAKAWA. *Tohoku Univ., Sci. Reports*, **19**, *pp.* 152–161, *June*, 1940. *Report No.* 475 *of the Research Inst. for Iron, Steel and other Metals.*—The change in electric resistance of 3 single crystals having principal axes and of a poly-crystal of Fe at low temperatures, 0°, −95° and −195°, was measured up to 1 400 oersteds in a longitudinal magnetic field, and the intensity of magnetization of these specimens was also measured under the same condition. Specimens used were cylindrical rods, 2·0–2·4 mm. in diameter and 3·2–13·4 cm. in length. The magnetoresistance curves of single crystals of iron at various low temperatures are almost similar to that obtained at room temperature. The magnetoresistance/temperature curves for 3 principal directions are nearly similar to each other; but for all the principal directions $\Delta R/R$ increases as the temperature decreases. AUTHOR.

3023. Phenomenological theory of superconductors. E. COOK. *Phys. Rev.*, **58,** *pp.* 357–361, *Aug.* 15, 1940.—Proceeding from the idea that the superconducting electrons are free classical particles under the influence solely of the electric field, London found it necessary to make an integration constant vanish arbitrarily in order to obtain agreement with the Meisner effect. A variation principle constructed from the same classical ideas gives the experimental result without resorting to an additional assumption. The very precise linear approximation results in London's equations; the rigorous theory has the same qualitative character. Unlike Mie's theory, the present theory has a satisfactory gauge invariance. AUTHOR.

3024. Complete data and boundary conditions for a superconductor. E. COOK. *Phys. Rev.*, **58,** *pp.* 361–364, *Aug.* 15, 1940.—When the applied fields and the total charge on each conductor are known, the solution of the London equations for a superconductor in the steady state is completely determined by requiring the continuity of the magnetic field and of the tangential components of the electric field. This result is incompatible with the somewhat prevalent notion that the lines of current flow rotate with the conductor. The solution for a non-steady state is uniquely determined by the additional specification of **E, H, J** throughout the system at some particular time. AUTHOR.

DIELECTRICS AND CAPACITANCE.

3025. Charge distribution and dipole moment of the C–H Bond. C. A. COULSON. *Cambridge Phil. Soc., Proc.*, **36,** *pp.* 509–510, *Oct.*, 1940.

3026. Breaking down of the orientation polarization in polar liquids. S. OKA. *Phys. Math. Soc. Japan, Proc.*, **22,** *pp.* 423–429, *June,* 1940. *In German.*—The variation of the breakdown of the orientation polarization in polar liquids by static fields with time is investigated theoretically, and it is shown that, if saturation phenomena are taken into account, the attainment of equilibrium is usually the result of the superposition of an infinite number of exponential functions with different relaxation times. If saturation conditions are not considered, only one relaxation time is obtained which is identical with that characteristic of the disappearance of the equilibrium state. A. J M.

ELECTROCHEMISTRY.

3027. Triple ions and transference numbers. M. DOLE. *Electrochem. Soc., Trans.*, **77,** *pp.* 385–394; *Disc.*, 395, 1940.—The influence of the formation of triple ions on the variation of transference number with change of concentration is discussed and the theoretical equations derived are tested by means of the recent data of Lanning and Davidson on the transference numbers of acetates in anhydrous acetic acid. AUTHOR.

3028. Energy states of valency electrons in some metals. M. SATÔ. *Tohoku Univ., Sci. Reports,* **19,** *pp.* 87–112, *June,* 1940. *Report No.* 472 *of the Research Inst. for Iron, Steel and other Metals.*—[See Abstract 3723 (1937).] The absolute values of the potential barrier in the following electrodes were recomputed and corrected for a normal H-electrode at 25°C., 4 076 mV, and for the surfaces of Zn-crystal

	(0001),	$(10\bar{1}0)$,	$(11\bar{2}0)$,	$(10\bar{1}1)$,	$(11\bar{2}1)$
In H_2SO_4-solution	3 202	3 226	3 240	3 252	3 264
in $ZnSO_4$-solution	3 318	3 319	3 321	3 311	3 315

at 25°C. in mV. The above value for hydrogen corresponding to ν 32 938 cm^{-1}. was compared with molecular levels of H_2 and found in magnitude between B, $1s\sigma$, $2p\sigma\ {}^1\Sigma_u$, $V = 0 : 33\,561$ and $V = 1 : 32\,262$ cm^{-1}. where V is the vibrational quantum number. The explanation of the experimental result of the photo-electric phenomena of adsorbed hydrogen obtained by Cashman and Huxford is revised and the mechanism of detaching a photo-electron from the H_2-molecule in the secondary maximum in the photo-electron emission is considered. By analogy, the mechanism of the photo-electron emission by Zn in the excitation of a photon with energy near its threshold value is given. AUTHOR.

3029. Irreversible electrode phenomena of thallium. Part I. Hydrogen overvoltage in sulphuric acid. I. M. LEBARON AND A. R. CHOPPIN. *Electrochem. Soc., Trans.*, **77,** *pp.* 289–297, 1940.—The overvoltage of Tl in H_2SO_4 solution has been determined. A wide variation in concentration and in temperature was used. A negative temperature coefficient of about 0·0032 V was found. No mechanism is proposed, but the data are applied to the mathematical derivations of Bowden. AUTHORS.

*3030. **Small-scale electrodialysis cell.** H. B. COLLIER. *Canad. J. of Research, B*, **18,** *pp.* 252–254, *Aug.*, 1940.—An electrodialysis cell for removing electrolytes from small volumes of colloidal solutions is described. On dialysis of a solution half-saturated with ammonium sulphate only 2% of the salt remained after 3 hrs. AUTHOR.

*3031. **New types of electrodes for potentiometric and conductometric titrations.** H. GOTÔ. *Tohoku Univ., Sci. Reports*, **19,** *pp.* 9–21, *June*, 1940.—Several new kinds of convenient electrodes for the potentiometric titration were devised. By means of these electrodes neutralization-, oxidation- and precipitation-titrations were carried out. Platinized and gold-plated glass electrodes were made and applied to the conductometric titration. AUTHOR.

ELECTRONS, NEUTRONS, POSITRONS AND PROTONS.

3032. Spin-orbit coupling in He^5. S. M. DANCOFF. *Phys. Rev.*, **58,** *pp.* 326–331, *Aug.* 15, 1940.—Experimental results on the splitting of the ground state of He^5 are compared with the structures which would be expected on the basis of (*a*) Thomas relativistic spin-orbit coupling and (*b*) the tensor spin-orbit interaction of mesotron theory. It is found that the Thomas coupling, as customarily formulated, gives an inverted doublet which is several orders of magnitude too small. The tensor force gives a result of the same order of magnitude as the experimental splitting and of the " normal " structure; these latter results can be established, however, only for a non-singular behaviour of the potential function. A modified treatment of the relativistic spin-orbit coupling, suggested by Breit, is discussed, which would account for the existence of widely spaced spin-orbit multiplets. AUTHOR.

3033. Complete isometric consistency chart for the natural constants *e, m* and *h*. J. W. M. DUMOND. *Phys. Rev.*, **58,** *pp.* 457–466, *Sept.* 1, 1940.—The paper shows in greater detail the construction and use of a consistency chart described previously [Abstract 3780 (1939)] and exhibits the present status of the dilemma regarding the values of *e*, *m* and *h*.

3034. Value of the electric quadrupole moment of the deuteron. A. Nordsieck. *Phys. Rev.*, **58,** *pp.* 310–315, *Aug.* 15, 1940.—The gradient of the electric field at the nucleus in the H-molecule is calculated from a new electronic wave function which gives a simple but accurate formula for the electron density. The wave function is found by a generalization of the procedure first used by Wang. The calculated field gradient, together with the molecular beam measurements of Kellogg, Rabi, Ramsey and Zacharias, determines the value of the electric quadrupole moment of the deuteron. As stated by the latter authors, the quadrupole moment is $2{\cdot}73 \times 10^{-27}$ cm^{-2}. The writer estimates the limits of error of this value to be ± 2%. Author.

3035. Mechanism of reactions involving excited electronic states. J. L Magee. *J. Chem. Phys.*, **8,** *pp.* 687–698, *Sept.*, 1940.—In many of the reactions of the alkali metals with the halogens the reacting system changes from a homopolar to a polar state, or vice versa. The possibility of a restriction on this change is considered, and it is concluded that there will be a serious restriction only for some of the atomic reactions $M + X \rightarrow MX$, which are of little importance. The crossing points between the polar and homopolar states for the reactions $M_2 + X \rightarrow MX + M$, $M + X_2 \rightarrow MX + X$ are drawn in so close that the interaction is large enough to ensure transition. Due to the 3-fold degeneracy of the initial state of *b* (which arises because X is in a *P* state) this reaction has the possibility of leading directly to the excitation of the M atom which is formed. The nature of the potential surfaces for this process are considered. The process first suggested by Polanyi, the excitation of M atoms by vibrationally excited MX molecules, is discussed. This process is possible because of a crossing of the 2 lowest polar states for the M_2X system. These 2 surfaces cross for a certain isosceles triangular configuration. Reacting systems thus easily go from the lowest to the second state in this region. Author.

3036. Ionization and dissociation of water vapour and ammonia by electron impact. M. M. Mann, A. Hustrulid and J. T. Tate. *Phys. Rev.*, **58,** *pp.* 340–347, *Aug.* 15, 1940.—The results of a mass-spectrometric study of the products of ionization and dissociation of water vapour and ammonia by electron impact are given. The ionizing potential of the H_2O molecule is found to be 13·0 ± 0·2 V, and of the NH_3 molecule 10·5 ± 0·1 V. The possible processes responsible for the formation of the various ions observed, both positive and negative, are discussed. Ions observed in H_2O vapour are H_2O^+, OH^+, O^+, H^+, H_2^+, H_3O^+, O^-, and H^-. Ions observed in NH_3 are NH_3^+, NH_2^+, NH^+, N^+, H^+, NH_3^{++}, NH_2^-, and H^-. Authors.

3037. Multiple scattering of fast electrons and α-particles, and "curvature" of cloud tracks due to scattering. E. J. Williams. *Phys. Rev.*, **58,** *pp.* 292–306, *Aug.* 15, 1940.—According to a number of observers the multiple scattering of fast electrons by thin foils is appreciably less than the scattering predicted by the theory of this effect given some time ago by the present author. The statistical part of the theory, which in the earlier work was developed with special regard to the scattering of cosmic-ray particles, has been reconsidered more closely for the conditions of the experiments on fast electrons. The results confirm within a few percent the scattering given by the earlier general formula. The discrepancies

must accordingly be attributed to experimental error or to a failure of the basic collision theory. A new formula is given which represents the mean projected deflection within 1% over the whole range of experimental conditions. The distribution of the projected deflections is considered more closely than in the earlier paper and a general expression for the most probable deflection in space is also given. The theory is extended to the multiple scattering of α-particles, the quantum-mechanical collision theory in this case taking the form of classical mechanics. The results are in satisfactory agreement with the early experiments of Geiger and of Mayer. A discussion is given of recent papers on the subject. Reasons are given for the non-operation of the interference effect considered by Wheeler, which according to him appreciably reduces the scattering. The numerical results of a new treatment of multiple scattering by Goudsmit and Saunderson are shown to be the same as those required by the general formula given by the writer's theory. Other points raised by these authors are also discussed. A summary of the theoretical results is given.
AUTHOR.

3038. Temperature effects in secondary emission. D. E. WOOLDRIDGE. *Phys. Rev.*, **58**, *pp.* 316–321, *Aug.* 15, 1940.—Measurements have been made on the effects of temperature changes on the emission of secondary electrons from Fe, Ni, Co and Mo. Abrupt changes of 1 or 2% were observed to accompany the $\alpha - \gamma$ transition of Fe, while the hexagonal to face-centred cubic transformation of Co was accompanied by a change in secondary emission of only about 0·4%. The magnetic transformation was found to alter the secondary emission coefficient of Ni by less than 0·3%. The temperature coefficient of secondary emission, in the cases of Ni, Ci and Mo, was found to be much less than the volume coefficient of expansion of the metal. The smallness of the temperature coefficient and the effect of the magnetic transformation are shown to lend support to the view that the secondary electrons are scattered or "absorbed" by an excitation process similar to that whereby they are originally produced.
AUTHOR.

3039. Scattering of thermal neutrons by crystals. F. RASETTI. *Phys. Rev.*, **58**, *pp.* 321–325, *Aug.* 15, 1940.—The effect of crystal interference on the scattering coefficient for thermal neutrons was investigated under different conditions. Calcite shows a large interference effect, the effective molecular cross-section for scattering by a single crystal being about 3 times smaller than for a microcrystalline aggregate. It is also shown that a single crystal becomes more transparent when the velocity of the neutrons is decreased. Scattering has also been measured for Bi and Pb, where the difference between a single crystal and the microcrystalline material is less pronounced. The scattering in the latter case is the same as found for the liquid. Cooling the crystal to liquid nitrogen temperature does not produce any considerable change in scattering. The cross-section for 90% Pb^{206} was measured and found to be the same as for the ordinary isotope mixture.
AUTHOR.

3040. Scattering of neutral mesons. F. BOOTH AND A. H. WILSON. *Cambridge Phil. Soc., Proc.*, **36**, *pp.* 446–453, *Oct.*, 1940.—Expressions are obtained for the scattering of neutral mesons by protons according to the quantized theory. It is found that the scattering due to the g_1 (point charge) interaction is much less than for charged mesons, but that the anomaly in the scattering due to the g_2 (dipole) interaction remains. The bearing of this upon recent attempts to modify the theory by introducing nuclear particles with charge 2*e* or — *e* is discussed. AUTHORS.

3041. Deuteron bombardment of the heavy elements. R. S. KRISHNAN AND E. A. NAHUM. *Cambridge Phil. Soc., Proc.,* **36,** *pp.* 490–499, *Oct.,* 1940.—The results of the bombardment of Hg, Pb and Tl, by 9 eMV deuterons are reported. The following radioactive isotopes have been detected: 5·5 min., 48 min., 36 hr., 60-day Hg isotopes; 4·4 min., 10·5 hr., 44 hr., and 13-day Tl isotopes; 10·25 min., 2·75 hr., and 54 hr. Pb isotopes; 18 hr. and 6·35-day Bi isotopes. The 10·25 min. Pb isotope is positron-emitting; an interesting result is an element of high atomic number. Absorption measurements have been made of the radiations emitted by many of these isotopes, and assignments have been made in most cases. AUTHORS.

3042. Deuteron bombardment of silver. R. S. KRISHNAN. *Cambridge Phil. Soc., Proc.,* **36,** *pp.* 500–506, *Oct.,* 1940.—A further study has been made of the deuteron bombardment of Ag. The following radioactive isotopes are formed: 2·4 min., 26 min. and 225-day along with the Ag fraction; and 6·7 hr. and 1-year along with the Cd fraction. Results of absorption measurements of the radiations emitted are given. The energy-yield curves have been determined for the 2·4 min. and the 26 min. Ag isotopes and also for the 6·7 hr. and 1-year Cd isotopes. The formation of the 26 min. body from Ag has been explained on the basis of a new type of disintegration, namely the (*d-p*, 2*n*) reaction. AUTHOR.

3043. Background in electron-diffraction patterns. A. HAQUE. *Phys. Soc., Proc.,* **52,** *pp.* 777–795, *Nov.,* 1940.—Intensity measurements have been carried out on the scattering of electrons by gold films of various thicknesses. The films were prepared by sputtering on cellulosic substrates as well as on rock salt. There was no regularity of scattering for gold films prepared on cellulosic substrates. Gold films prepared on rock salt do, however, give consistent results. The irregularity of scattering of the films prepared on cellulosic substrates was due to a layer of the cellulosic substrate which was interlocked in the gold films in such a way that it could not be removed by repeated washing. Detailed absolute measurements were made of the background for 2 gold films, 395 Å and 750 Å in thickness, prepared on rock salt. The distribution function of the background is practically constant within the range from 2° to 4°. A uniform background like this is probably due to plural inelastic scattering accompanied by diffuse scattering due to the thermal motion of the atoms in the crystallites. AUTHOR.

3044. Determination of the mass of C_8^{14} from the nuclear reaction N(n,p)C. O. HUBER, P. HUBER AND P. SCHERRER. *Helv. Phys. Acta,* **13,** 3, *pp.* 209–211, 1940. *In German.*—When nitrogen is bombarded with fast neutrons the following nuclear reactions occur: (1) $N_8^{14} + n_0^1 = B_5^{11} + He_2^4 + Q_1$, and (2) $N_7^{14} + n_0^1 = C_6^{14} + H_1^1 + Q_2$. The mass of C_8^{14} is found from (2) by measurement of Q_2, which is performed in an ionization chamber with linear concentrator filled with nitrogen into which neutrons are passed which have previously been retarded by passage through paraffin. From 1200 nuclear reactions, $Q = 0{\cdot}55 \pm 0{\cdot}03$ eMV, whereby $C_6^{14} = 14{\cdot}00775 \pm 0{\cdot}00019$. Pollard (*Phys. Rev.,* **56** 1168, 1939) had previously found C^{14} to be 14·00775 from the reaction C^{13} (*d, p*) C^{14}. H. H. Ho.

3045. Effective cross-section for elastic scattering and nuclear reactions of fast neutrons in N_2. O. HUBER, P. HUBER AND P. SCHERRER. *Helv. Phys. Acta,* **13,** 3, *pp.* 212–213, 1940. *In German.*—When nitrogen is bombarded with fast neutrons, elastic scattering occurs in addition to the nuclear reactions N(*n*, *α*)B and N(*n*, *p*)C, and the magnitudes of the effective cross-sections have now been found to be: $9 \cdot 7 \times 10^{-25}$ cm^{-2}. for elastic scattering and 2×10^{-23} cm^2. for both nuclear reactions together. The neutrons used were from a *d-d*-source and registration was made by an oscillograph. H. H. Ho.

***3046. Design and performance of an electron diffraction camera.** J. E. RUEDY. *Rev. Sci. Instruments,* **11,** *pp.* 292–295, *Sept.,* 1940.—An electron diffraction camera has been built for use in the study of photo- and secondary-electron emissive surfaces. The electron beam is produced by a modified cathode-ray tube gun having an a.c. heated tungsten wire cathode, for which the focusing voltages are supplied by rectifiers. Beam velocities up to 40 kV are available. The maximum beam current, after reduction by a screening aperture, is about 0·1 μA, which is sufficient to make visible most patterns which can be photographed. The specimen adjustment mechanism and photographic shutter control are of new design and have proved themselves very satisfactory. The pumping system consists of a Megavac fore pump and a 4in. diam. 3-stage oil diffusion pump. AUTHOR.

See also Abstracts 2872, 2875, 3050.

MAGNETISM AND ELECTROMAGNETISM.

3047. Theoretical study of a possible model of paramagnetic alums at low temperatures. J. A. SAUER AND H. N. V. TEMPERLEY. *Roy. Soc., Proc. A,* **176,** *pp.* 203–213, *Oct.* 9, 1940.—An attempt is made to examine theoretically the properties of paramagnetic alums at low temperatures. The model taken is a lattice of freely suspended magnets, all interactions except purely magnetic being neglected. Even with this simplification it is impossible at present to make rigorous calculations of the partition function, either on classical or quantum lines. A simple model is proposed, which is really a generalization of the Bragg-Williams theory enabling one to take account of the effect of a magnetic field. The few configurations whose energies are known are used to fix arbitrary constants in the expression assumed for the energy. The theory predicts that the state of lowest energy is either a spontaneously magnetized state for a long thin specimen, or a state in which alternate rows of magnets point in opposite directions for a sphere, spontaneous magnetization appearing in an ellipsoid with an eccentricity greater than a certain critical value. The transition curve bounding the region in which the antiparallel state is stable consists partly of a line of Curie points corresponding to transitions of the second order, passing smoothly into a line of critical points corresponding to a transition of the first order. The effect of shape on the magnetic properties of the specimen seems to be experimentally verified, but the rough nature of the theory prevents it being more than qualitative. AUTHORS.

MEDICAL RADIOLOGY AND ELECTROLOGY.

3048. Use of artificially produced radioactive elements as tagged atoms in biological research. W. F. BALE. *Radiology,* **35,** *pp.* 184–191, *Aug.,* 1940.—A general account is given of the principles underlying the use of radioactive elements in tracing biological processes *in vivo*, together with a short description of a Geiger counter tube arrangement suitable for this work. A number of the more important investigations in this field are then summarized. They include experiments on iron metabolism in anaemic animals, photosynthesis in plants using radio-carbon, arsenical poisoning of insect pests using the radio-isotope, and the metabolism and biological functions of phosphorus, particularly in connection with the problem of calcification. There is promise of considerable extension of the usefulness of these methods. J. E. R.

3049. Physical factors of l.v. contact X-ray therapy. C. B. BRAESTRUP AND I. H. BLATZ. *Radiology*, **35,** *pp.* 198–205, *Aug.*, 1940.—Comparative accounts are given of the Chaoul and Philips apparatus for l.v. X-ray treatment at short distances. The physical factors of the Chaoul apparatus have been investigated by previous authors and the present work is devoted chiefly to the Philips air-cooled type of apparatus. In all, 7 generators have been tested. The tests cover voltage and ripple measurements, X-ray output, absorption of X-rays in Al and percentage depth dose. The Philips tube has some advantages over the Chaoul type owing to the smaller target distance and much lower inherent tube filtration. An examination of the stray radiation in the neighbourhood of the tube shows dose rates of the order of 0·04 r./min. at significant positions. These values are rather high, but this is offset by the high tube output which results in very short treatment periods. J. E. R.

***3050. Multi-channel delay unit.** W. H. MARSHALL AND S. A. TALBOT. *Rev. Sci. Instruments*, **11,** *pp.* 287–289, *Sept.*, 1940.—Details are given for the construction of a time delay circuit of particular value for physiological laboratories using oscillographs for studying action potentials of the nervous system. It permits timing separate events at any interval in a cycle of operations determined by a master oscillator. The operation of the circuit depends on the grid extinction of a thyratron operating at low current. AUTHOR.

PHOTO-ELECTRICITY.

See Abstracts 2964, 2997.

THERMO-ELECTRICITY.

3051. Benedicks effect in gas-free mercury, photographically registered: influence of mean temperature. Part VIII. C. BENEDICKS AND P. SEDERHOLM. *Arkiv f. Mat. Astron. och Fysik, Stockholm,* **27A,** 9, [19 *pp.*], 1940.—The Benedicks effect has been further investigated for gas-free Hg with improved apparatus, in which the galvanometer deflections are recorded photographically. Gas-free Hg was found to give a positive first Benedicks effect. The effect varies with temperature, the gradient of the temperature curve increasing rapidly with increasing temperature. [See Abstract 2663 (1939).] A. J. M.

***3052. Construction of very sensitive vacuum thermo-electric cells.** F. T. ROGERS, JR. *Rev. Sci. Instruments*, **11,** *pp.* 281–282, *Sept.*, 1940.—A new and reliable technique is described for the construction of thermocouples of high sensitivity, suited especially to astrophysical research. The technique consists essentially of a controlled-heating soldering process for very small bismuth alloy parts. The mounting of such thermocouples in permanently evacuable glass envelopes is also discussed. AUTHOR.